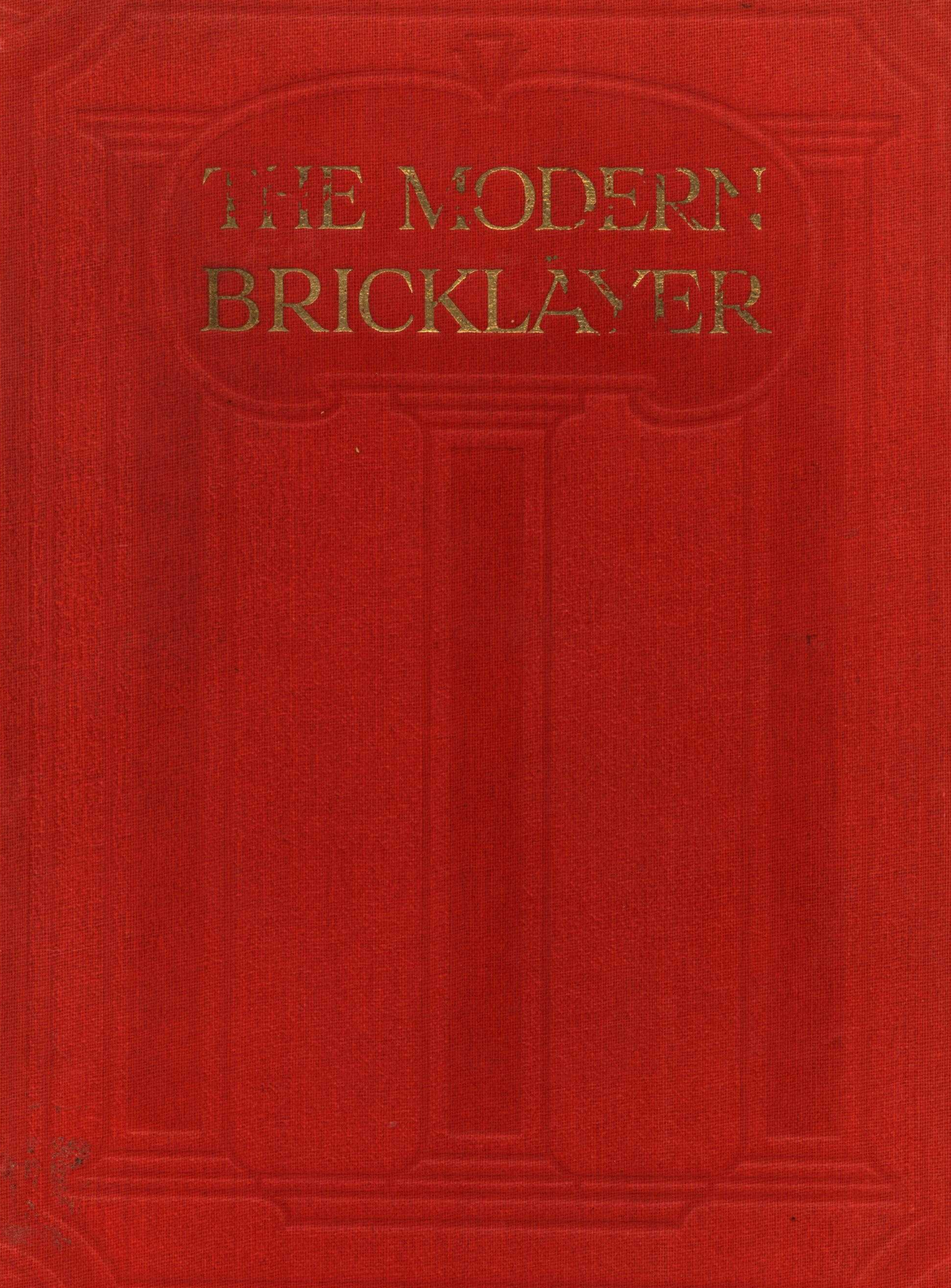

THE MODERN BRICKLAYER

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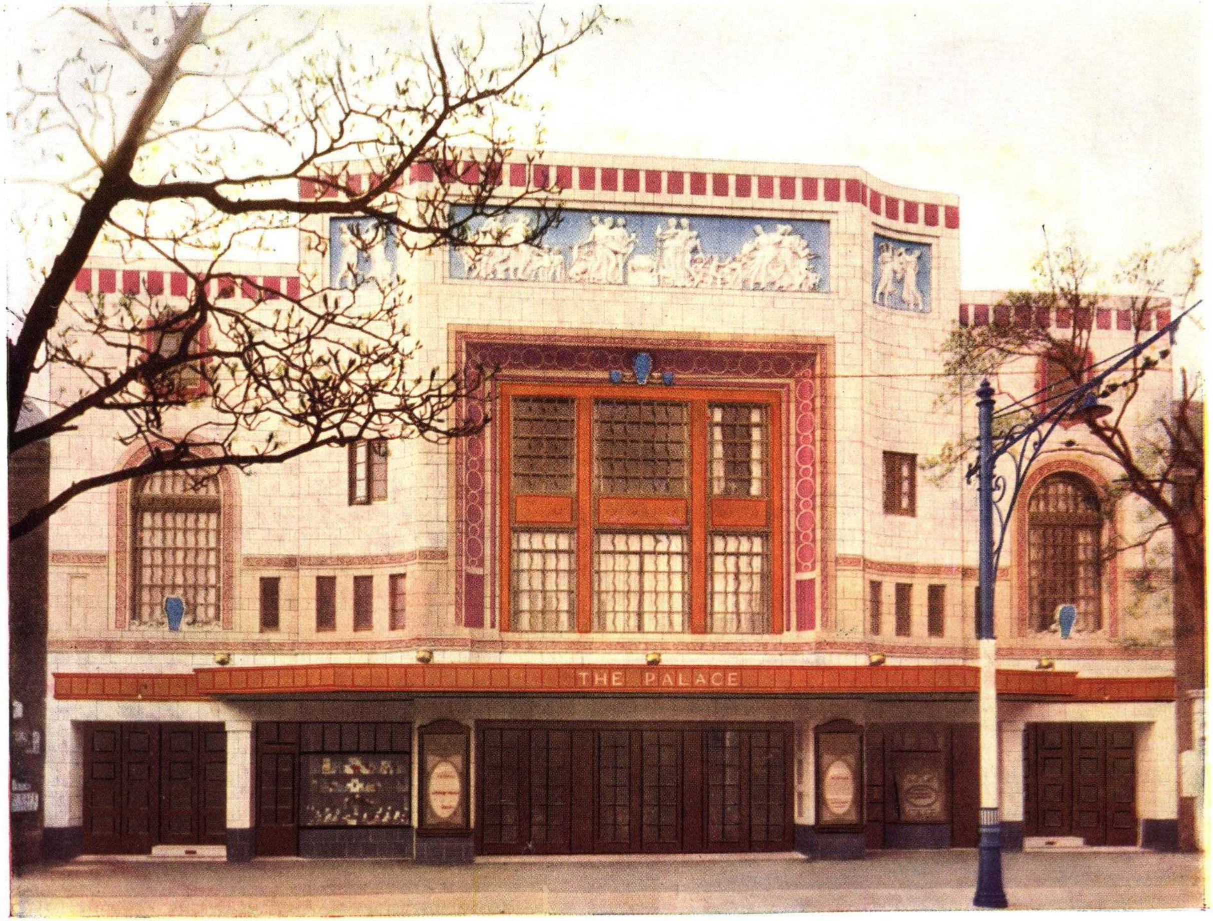
THE MODERN BRICKLAYER

VOLUME II



CINEMA FAÇADE IN POLYCHROME CERAMIC BLOCKS AND TILES.

Shaw's Glazed Brick Co. Ltd., Darwen, Lancs.

[*Frontispiece.*

THE
MODERN BRICKLAYER

A PRACTICAL WORK ON BRICKLAYING IN ALL ITS BRANCHES

WITH
SPECIAL SECTIONS ON
TILING AND SLATING, SPECIFICATIONS,
ESTIMATING, Etc. Etc.

BY
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OF THE CITY AND GUILDS OF LONDON INSTITUTE

VOLUME II

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THE MODERN BRICKLAYER

VOL. II

CHAPTER I

HOUSE DRAINS

Drain Pipes—Testing—Sizes—Manufacture of Glazed Stoneware—Parts of Pipes—Drains and Sewers—Types of Pipes—Jointing of Pipes and Traps—Patent Joints—Self-adjusting Joint—Free-flow Joint—Moist Shoulder Joint—Double-seal Joint—Hassall Double-lined Joint—Sykes Joint—Parker Joint—Stanford Joint—Hassall Single-line Joint—True Invert Joint—Drain Laying and Levelling—Intercepting Chambers—Details of Chambers—Traps and Gulleys—Clearing of Drains—Walls of Chambers—Catchpits—Quality of Brickwork—Connections with Main Drain—Gradients—Intercepting Traps—Stoppages in Drains—Testing Old and New Drains—By-laws.

HOUSE drainage forms a very important part of the bricklayer's work. It includes the taking of the various levels for the drain, the laying and jointing of the pipes, traps, etc., and the building of the intercepting and inspection chambers, as well as the finishing of all paths, yards, etc., to a finished level with proper falls. There are various points that should be strictly adhered to when constructing any drain, viz.:

(1) Good craftsmanship should particularly be applied to all classes of sanitary work.

(2) All material supplied should be of a high quality; all pipes and traps of sound non-absorbent type, watertight, and of uniform bores throughout their various lengths. They should be properly glazed, internally and externally, to ensure their being watertight. Every joint should be made of a good Portland cement and properly constructed.

(3) All levels should be correctly determined, and the proper falls given to the main drain and all its branches.

(4) All drains and branches should be laid in straight lines whenever possible. Where this, for some unavoidable cause, is impossible, and bends are necessary, they should be constructed with easy curves so as not to impede the flow of sewage. If a sharp angle is necessary in the lines of the drainage, or any other change in the direction of the drain, where an easy curve could not be constructed, it will then be necessary to place an inspection chamber at these points, which forms an easy access to the drain in the case of a stoppage taking place, and also for periodical cleaning of the drain.

(5) The drain should not be larger than necessary to take the maximum flow of sewage, rain, or surface water.

(6) All drains should be laid outside a building whenever possible. If this is not possible and they have to be laid inside the building, they should be of cast iron with molten lead joints.

(7) All points of access to the drain should be outside of the building.

(8) The main drain should be disconnected from the sewer by an intercepting trap.

(9) The drain should be properly ventilated.

(10) No square or right angle junctions must be used.

(11) All inlets from soil pipes should run direct into the drain, and water from baths and sinks should discharge over a trapped gulley before entering the drain.

When fixing a sink, etc., the by-laws of the London County Council require waste pipes to be trapped immediately below the fitting by means of a siphon trap with adequate means for inspection and cleansing.

Good craftsmanship combined with good materials will ensure an efficient house drain; good craftsmanship combined with poor material, or good material combined with bad craftsmanship, cannot make a good drain, therefore the two, good craftsmanship and good material, must be secured. Moreover, sound craftsmanship in relation to sanitary work is essential to the safety of the Public Health.

DRAIN PIPES

All material such as pipes, traps, bends, junctions, etc., should be of a high quality.

All drain pipes should be well burnt, thoroughly glazed throughout their length internally and externally; they should be circular in shape and possess a uniform bore throughout their length and be straight. They should be free from defects such as cracks, pinholes, blisters, etc. Stoneware drains, when properly constructed with good Portland cement joints, should stand the water test and are equally as good as the cast iron drain, where the ordinary house drainage system is required.

Testing.—All pipes should be tested before use as to their soundness. The bricklayer generally tests them by holding the pipe in one hand and tapping it with the blade of the trowel with the other, when it should give a sharp metallic sound. As regards the hydraulic test, all pipes from any reputable firm are tested before they leave the works.

Sizes.—The thickness of the 4-inch pipe should be ⅝ inch, 2 feet in length, depth of socket 1¾ inches and weight about 9 lb. The 6-inch pipes are generally about ¾ inch to ⅞ inch in thickness, 2 feet in length, depth of socket 2 inches, and weight about 16 lb. The 4 inches and 6 inches as mentioned in these pipes are the internal diameters. These pipes are also made in 3-foot lengths, but the only variation would be the weight of the pipe. There are also larger pipes made, but the two sizes that the bricklayer generally deals with are the 4-inch and 6-inch pipes. The

3-inch pipe is not very often used now; most local authorities insist upon the 4-inch pipes being used for surface water, rain-water, and soil.

Stoneware drain is also non-corrosive. Drain pipes are salt glazed, which makes them impervious. This form of glazing causes the glaze to enter the pores of the material. Lead glazing, being only a surface glaze, is not so effective, especially when the glaze gets chipped off the surface, and the inside material is of a porous nature. They are made either of ordinary burnt clay glazed or of stoneware, the latter being the better and the easier to handle with success.

Manufacture of Glazed Stoneware

The class of ware known as salt-glazed stoneware originated with Doultons, Lambeth, early in the eighteenth century and has since remained the staple manufacture of the district. I am indebted to Messrs. Doulton for the following notes on the manufacture of the drain pipe.

Glazed stoneware strongly recommends itself for all classes of drain work on account of its cheapness, imperishability, and non-conducting properties. Its suitability for underground work is indicated by the universal use of drain pipes, sewers, etc., during the past seventy-five years. No material is more chemically inert, it is fireproof, and secure against corrosion. The clay is quarried in the open, and resembles rock in its raw state. It is elevated in tubs to an upper floor, where it is discharged into one of the many grinding mills. These mills consist of dry grinding pan mill sieves, wet mixing pan mills, kneading mills, elevators, and conveyers. The clay enters in the raw state as it is quarried and is discharged from the mills in a plastic state ready for moulding. It is then conveyed to another system of elevators and conveyers for removal to the presses, of which there are a great number. Each press consists of an inverted cylinder actuating a plunger which enters a cylindrical chamber. Into this chamber the clay is conveyed and is forced under great pressure through a die at the bottom. In the manufacture of pipes, the socket is extruded or comes out first, and is followed by the barrel of the pipe. The two operations are distinct from one another though consecutive. The moulded pipe is then cut off to the required length, that is, 2 feet or 3 feet as may be required. This is performed by a cutting wire. The pipe, which is still in its plastic state, is taken from here to the drying rooms. These rooms are heated by the exhaust steam from the presses. The pipes remain in this room until all the moisture is extracted from them. The time of drying varies from a day or two to several weeks, according to the size and thickness of the pipes. This drying is carried out gradually so as to avoid any warping or cracking of the material. When thoroughly dried, they are ready to be fired. The pipes at this stage are white and hard. They are taken and set up in the kilns, which are of the down-draught type. These kilns take about 35 tons of the material. In the heating of these kilns, the furnace gases from a number of coal-fed furnaces, which are built in the wall and rise to the crown, descend through the ware and are then conducted through underground flues to an external shaft. When the full temperature is obtained (about 1,250 degrees Centigrade) the contents of the kilns are incandescent, or, in other words, white and glowing with heat. Common salt is then introduced, which volatilises and penetrates the surface of the pipes, converting it into a glass, the partial fusion of the clay itself thus forming the so-called salt glaze. These burning operations in each kiln occupy a period of about 10 days. During this burning process, the amount of shrinkage which takes place in the material is something like 10 per cent.

Sometimes a patent (the Stanford) joint is applied to the drain pipes. This joint was introduced by Doulton over 40 years ago, and they have supplied many to various builders since that period. In applying the bituminous composition to this form of joint, machine jigs are employed to obtain the accurate alignment of the pipes. At the spigot and socket ends of the pipes, the glaze is chipped off previous to applying the compound to enable a better key or grip for the adherence of the compound.

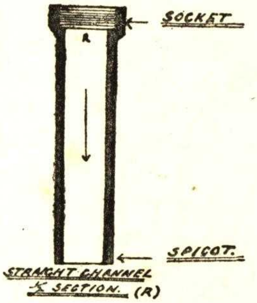


Fig. 1.

Bends of various angles are formed by the operator, in which he draws the clay out from the press sideways, and at any angle which can be obtained.

Parts of Pipes.—The bodies of pipes are known as the barrels. Most pipes are constructed with a widened socket with raised collar, in which the plain or spigot end is fitted. In some pipes the collar is pierced with a hole or vent, through which liquid cement or grout is poured. The lower side of the pipe is known as the invert, and the upper as the crown.

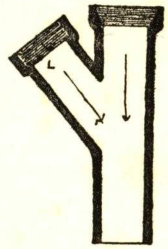
Drain and Sewer.—A drain is any pipe or conduit used to convey rain-water, house waste, etc., of one building or a number of buildings within the same curtilage or boundary. A sewer means all conduits and drains which are under the direct control of the local sanitary authority.

Types of Pipes.—There are many kinds of pipes which the bricklayer uses in the construction of house drainage, and some of these must be described before explaining the actual laying of the drain.

Fig. 1 represents a straight 2-foot length of 4-inch half section channel pipe. These are made in half sections and are either lead glazed or salt glazed. They are generally used in inspection chambers and form the main channel. They possess a socket and spigot for the circular pipes to join them at either end.

Fig. 2 is an illustration of the 4-inch Y junction. These, like the half section straight channel, are made in various sizes, 4-inch, 6-inch, and 9-inch. The branch from the straight pipes is made in different " hands," as it is termed in the trade. This figure shows a left hand Y junction. This is also used in inspection chambers, and the arm at the left hand side constitutes part of the branch drain within the chamber.

Fig 3 is an illustration of the breach channel junction. This is also a 4-inch half section used in manholes, and contains two branches at the end of the straight channel, which take two branch drains coming into the main channel in different directions. The direction of flow is shown by the arrow marks. The two branches contain sockets for pipes to be jointed to them.

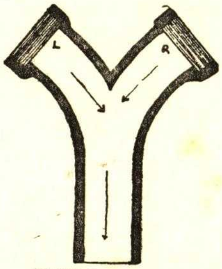


SINGLE Y JUNCTION (L)
CHANNEL ½ SECTION

FIG. 2.

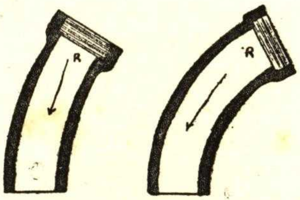
Fig. 4 shows the section of a 4-inch "easy" half section channel bend. These are again used in inspection chambers, where change in direction of flow is necessary. They are also used as branch channels as well as main channels.

Fig. 5 is another 4-inch half section bend. This is a medium bend, it being at a sharper bend than the first. This is also used for the same purposes as the easy bends.



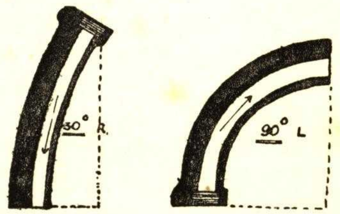
BREECH JUNCTION
CHANNEL ½ SECTION.

FIG. 3.



EASY AND MEDIUM BENDS.
CHANNELS ½ SECTIONS.

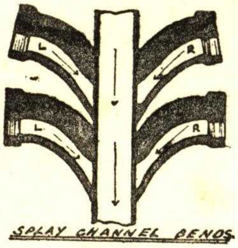
FIGS. 4 and 5.



LONG EASY CHANNEL BENDS
LONG SHARP CHANNEL BEND
¾ SECTIONS.
R DENOTES RIGHT
L DENOTES LEFT

FIGS. 6 and 7.

Fig. 6 is an illustration of the 4-inch three-quarter section long easy channel bend. It is used in the inspection chamber as a branch channel bend on the side of the main channel. The angle of this bend you will see is 30 degrees.



SPLAY CHANNEL BENDS
¾ SECTION.

FIG. 8.

Fig. 7 is an illustration of the long sharp bend which is also 4-inch and three-quarter in section, and is used for the same purpose as the long easy bend. This angle is 90 degrees, and, as will be noted, the long easy bend is a right hand, and the sharp bend is a left hand bend. The direction of flow is shown in both cases by the arrow indications.

Fig. 8 shows an illustration of a main 4-inch half section channel, with left and right hand three-quarter section splayed channel bends, which form the branch channels fixed to it, two left hands and two right hands. Direction of flow is again marked by the arrow indications.

Fig. 9 is an illustration of a 4-inch P gulley trap with a 4-inch back inlet attached at the back of the gulley. The back inlet is for the purpose of receiving a down pipe such as a rain-water pipe. A 4-inch galvanised iron grid or grating is fixed at the top of the gulley, which rests in a rebate especially made for the purpose. These gulleys are made with outlets at various angles, the black portion as shown being called a P. The dotted lines indicate two other forms; the one marked A is called an S gulley and the one marked B is called a Q gulley outlet. The gulleys are placed at various points of the drains for the purpose of receiving various waste pipes, rain and surface water pipes, etc.

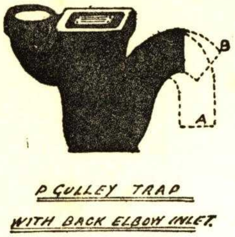


FIG. 9.

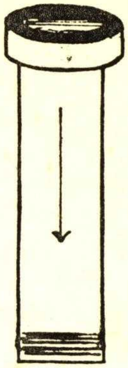


FIG. 10.

Fig. 10 shows an illustration of the ordinary 4-inch pipe, 2 feet in length. The majority of these are used in house drains. The direction of flow is shown by an arrow. These are also made in various lengths—3 feet, 1 foot 6 inches, and 12 inches lengths—in order to save unnecessary cutting.

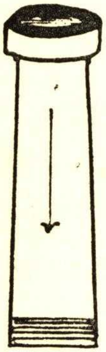


FIG. 11.

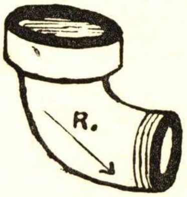


FIG. 12.

Fig. 11. This shows a reducing pipe, being 4 inches at the socket end and 6 inches at the spigot end of the pipe. These pipes are used as the joining piece from a small drain, say 4 inches, to a larger drain of 6 inches, or vice versa. For instance, if we have an intercepting chamber with a 4-inch intercepting trap which is required to joint a 6-inch drain on the sewer side of the intercepting chamber, it is at this point that the 4-inch socket of the reducing pipe is jointed to the spigot end of the 4-inch intercepter, the 6-inch spigot end of the reducing pipe joining the socket of the 6-inch drain which proceeds towards the sewer.

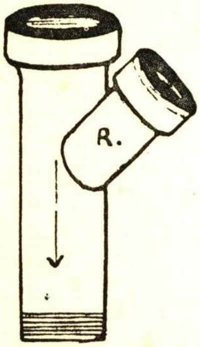


FIG. 13.

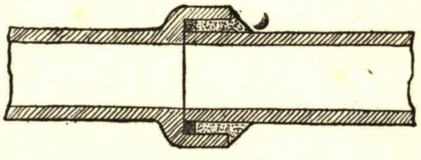
Fig. 12 is an illustration of the 4-inch knuckle bend, which is used where a sharp bend is required, such as the end of the fresh air inlet at the point where it joins the intercepting chamber. This is a right hand knuckle bend. (Lefts are also made.) Direction of flow is again indicated by the arrow. I might mention here that the flow in all cases should be directed against the socket of all pipes, channels, etc.

Fig. 13 shows another form of junction pipe.

JOINTING OF PIPES AND TRAPS

The jointing of the various pipes and traps is very important, because on them will depend the watertightness of the drain, therefore great care should be taken over this section of the work. One most used and the best joint for all ordinary situations is the cement joint.

Fig. 14 gives an illustration of the ordinary cement joint, showing the tarred yarn or gasket in the internal end part of the socket of the one pipe resting against the extreme end of the spigot end of the other pipe. It also shows the cement in between the socket and spigot of the two pipes, finished off at an angle of 45 degrees. The method of jointing consists of laying the two pipes in their correct positions, so as to obtain the proper fall, the first pipe, when laid in position, having the socket facing towards the bricklayer ready for jointing. The bricklayer or his labourer mixes the neat cement thoroughly to the required consistency, which should be in the form of a stiff paste not too soft. This should be mixed on a clean mortar board. The bricklayer takes a portion of cement with the small trowel from the board and spreads a layer of it completely round the internal part of the socket. The next pipe is then taken and the spigot end of it is placed into the socket, which is partly filled with cement. In placing the spigot end of the pipe into the socket of the first pipe, great care must be taken to ensure that the bores of the two pipes are uniform throughout, and also to make sure that the internal invert of the last pipe has not fallen below the internal invert of the first pipe, which is liable to cause a lip or ridge between the two pipes. If the cement is of the consistency of a stiff paste, the second pipe, when placed in position, will not drop below the first one. The spigot end of the second pipe should be firmly pushed against the socket of the first pipe, thus forming a thin tight joint of cement between the two pipes. The cement joint should then be made by the bricklayer by taking his small trowel and thoroughly pressing in the cement all round the pipe between the socket and spigot. When the joint has been made a reasonable time, it should be well trowelled and smoothly finished off at an angle of 45 degrees. Great care should be taken to make sure that the joint is solid, especially at the bottom part of the joint where it cannot be seen by the naked eye. A small mirror should be used when making the bottom of the joint. By holding it under the pipes, it can then be easily seen. Most of the leaks occur at this part of the joint, and are not so easily remedied as if they occurred at the top part of the joint.

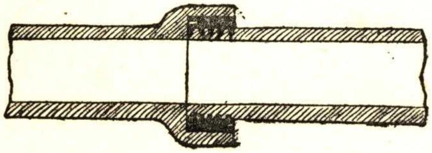


THE CEMENT JOINT.

FIG 14.

Each joint should be cleaned out internally as the pipes are jointed. This is done by means of a raker, which consists of two pieces of wood, one being a long handle about 3 feet in length, and the other, which is fixed at the top end of the handle, consists of a semicircular piece of wood of slightly less size than the half section of the pipe. This is pushed into the pipe, the end being lifted as it proceeds to a point a little past the joint. It is then allowed to rest upon the bottom of the pipe, and then pulled forward. By this action, the bottom half of the joint is cleaned. The raker is again pushed in and held in a reverse position to the half section disk of the raker at the top part. This upper portion of the joint is cleaned in the same manner by pulling the raker forward. In doing so, the surplus cement which has probably squeezed into the interior of the pipes when firmly pushing them together before completing the joint is pulled out in front of the raker. Great care must be exercised in this operation, so as not to disturb the pipes after they are jointed. If disturbed, they are liable to leak. Tarred yarn or gasket is sometimes used in making the cement joint. This is usually pushed in solid with a caulking tool, and the cement is filled in afterwards and finished off in the usual manner.

In making the cement joint, a good standard cement should be used. It should not be too fresh or hot, as it is termed, or it will expand and crack the collar or socket of the pipe in which the joint is made. If, on the other hand, it is too stale, it will contract in the collar of the pipe and cause leakage. For this purpose, the bottle test, which is a simple one, can be used; it has already been explained in the chapter on Mortars. A small proportion of sand is sometimes used with the Portland cement in making the joints; if used, it should be in a small percentage, sharp, and clean, and free from any loam or earthy matter. However small the proportion of sand which is used it tends to make the joints porous, and not so solid as the neat cement joint. If sand is used, the surface of the joint should be thoroughly trowelled in when finishing it at the angle of 45 degrees. The sand in the cement also prolongs the setting of the cement, the joints not setting so quickly as when Portland cement is used by itself.



DOULTON'S SELF ADJUSTING JOINT.

FIG. 15.

Patent Joints.—Fig. 15 is an illustration of a patent joint. This is known as the Doulton self-adjusting joint. It consists of two composition rings of bitumistic material, one ring of this material being attached to the internal part of the socket, and the other ring attached to the external extreme end of the spigot. The rings are segmental in shape. The two segments face each other and form a close joint. These joints are then filled in with neat Portland cement, and finished the same as the ordinary cement joint. This makes a double seal, and ensures the pipes being watertight. The pipes need no cleaning in this case internally, because there is no surplus cement which can penetrate the interior of the pipe, while the cement part of the joint is being constructed. The two bituminous rings also keep the pipes internally central with each other, and hold them in a firm position, while the cement portion of the joint is made. The sockets of these pipes are made longer than the ordinary sockets to include the composition rings and also the cement joint which forms the double-seal finish of the joint.

Self-adjusting Joint.—Fig. 16 is an illustration of the original Doulton's self-adjusting joint. This consists of two composition rings, one on the internal face of the socket, and the other at the external extreme end of the spigot, which are segmental in section as shown. These joints form a tight joint and are more pliable or elastic than the ordinary cement joint, and, being thoroughly watertight, are suitable for laying in bad ground, where there may be a slight tendency for the pipes to sag or sink a little. Being elastic, they will lock themselves if the pipes sag.

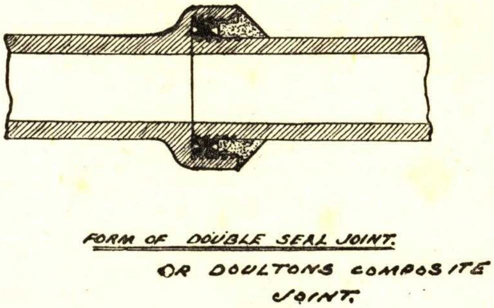


Fig. 16.

Free-flow Joint.—Fig. 17 is an illustration of the free-flow joint, which shows this joint with the external end of the spigot of one pipe, which is splayed, fitting into another splay in the internal part of the socket of the other pipe. When the spigot end of the one pipe is pushed firmly against the socket of the other pipe, the two splays fit against each other and the spigot end of the pipe is held in a central position, which enables both pipes to be in a horizontal position centrally with each other, and it also forms a uniform circular bag of cement between the internal part of the socket and external part of the spigot end of the pipe. The joint is then filled in in the ordinary way with neat Portland cement and finished at an angle of 45 degrees.

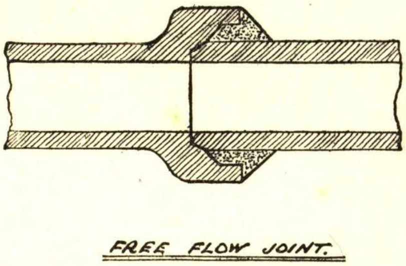


Fig. 17.

Invert Shoulder Joint.—Fig. 18 is an illustration of Doultons' invert shoulder joint. In this joint the spigot end of the pipe rests upon a shoulder piece which is formed on the bottom of the internal part of the socket of the other pipe. This holds the spigot end of the pipe in a central position. When placed on this shoulder piece, the other part of the joint is filled in by the ordinary method with neat Portland cement.

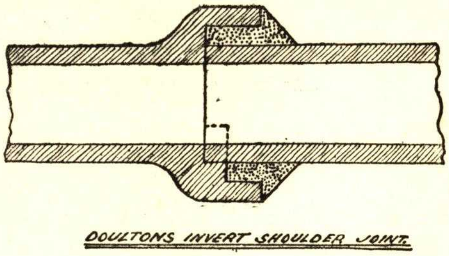
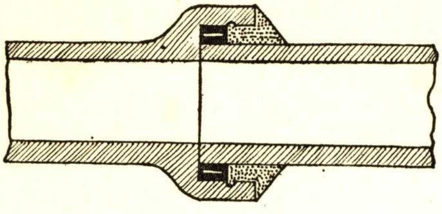


Fig. 18.

Double-seal Joint.—Fig. 19 is an illustration showing another form of the duoble-seal joint, which again is made up of two materials.

This also consists of two rings of composition, one on the external face of the spigot end of the pipe, and the other on the internal face of the socket. These two rings extend in length horizontally half-way in the socket. Next to this we have a grooved ring all round the internal face of the socket which forms an extra key for the cement joint when filled in. This forms the remaining portion of the joint, which is finished by the ordinary method.



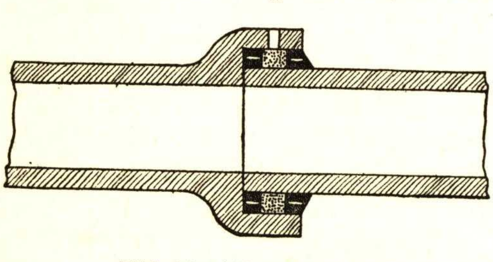
FORM OF DOUBLE SEAL JOINT

FIG. 19.

All these bituminous and composition rings in these various pipes hold them in a uniform central position.

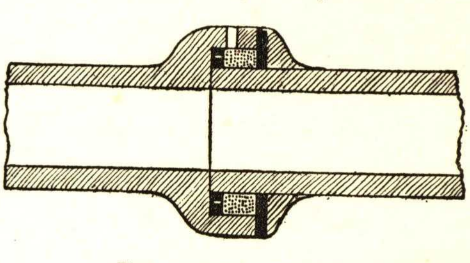
Hassall Double-lined Joint.—Fig. 20 is an illustration of the Hassall double-lined joint, which consists of two pairs of rings, two being in the internal part of the joint between the socket of one pipe and spigot of the other, and the other two being at the external part of the joint between the spigot and socket of either pipe. Between these two pairs of rings at either end of the joint, there is a space left into which liquid or cement grout is poured, which forms a circular band of cement between the two rings all round the pipe. This is poured in at the top of the socket of the pipe as shown in the illustration. The finish of the joint is made in the form of a splay, which is formed in the two external composite rings of the joint. This is a very good joint which really has three seals in its composition.

Sykes Joint.—Fig. 21 is an illustration of the Sykes joint. This shows a composite ring which is formed at the spigot end of one pipe in the form of a collar. The socket end of the other pipe fits against this ring, and also contains a double ring of composite in the internal part of the socket. A space is formed between these rings of composite, into which grout cement is poured through the hole at the top of the socket, which forms a circular band of cement round the pipe internally.



THE HASSALL DOUBLE LINED JOINT.

FIG. 20.



THE SYKES JOINT.

FIG. 21.

Parker Joint.—Another much used type is the Parker joint, which consists of a single band or ring of composite round the external end of the spigot. This band is invertically curved, as shown, which leaves a hollow ring round the pipe, into which cement is poured from the hole in the top of the collar. The invert in the composite rings forms a key for the cement band when poured in. Clay is sometimes placed at the end of the socket whilst the grout is poured in and afterwards taken away, and the joint finished when the cement is set.

Stanford Joint.—On the other hand the Stanford joint consists of a double ring of composite material, one being on the external face of the spigot end and the other being on the internal face of the socket or collar. These two rings are slightly splayed and fit tightly into each other, and by slightly screwing or twisting the spigot into the socket it forms a good tight joint.

Hassall Single-lined Joints.—The Hassall single-lined joint consists of two single rings of composite in the internal part of the joint, the grout cement being poured in at the hole in the top of the collar, the exterior portion being finished off sometimes with Portland cement, after the clay band has been taken away, which is usually placed in position to enable the central band of cement to be poured in.

True Invert Joint.—In the true invert joint, we have one which is composed of two single rings of composite, one on the internal face of the socket at the extreme end, the other ring a short distance from the end of the external face of the spigot end of the pipe. These two rings take up the space of half the depth of the collar. The internal space is filled in with liquid cement or grout, as shown in Fig. 20. The internal end of the socket of the pipe consists of a small collar piece; upon this the spigot end of the pipe rests. This ensures the pipes being centrally true.

There are various other patent joints on the market, but the few which have been explained will enable the bricklayer to understand the character and purpose for which they are used in different situations.

A bituminous mixture is sometimes used for joints where the drain is laid in bad ground or where the surrounding ground is of a spongy nature. This composition consists of pitch, asphalt, and sand, boiled in a receptacle and filled into the sockets of the pipes in a molten state, clay being fixed round the pipes externally while the composition is being poured into the joints. It is then allowed to cool, and the clay is then removed afterwards. This composition forms quite a good joint.

Drain Laying and Levelling

When a trench is laid to the correct gradient for the proposed drain, pegs are driven in the ground and levelled on the top with a long straight edge 10 feet in length. The top of the wooden pegs should reach the height of the proposed concrete. For a 4-inch drain to be laid a 3-inch wooden block is fixed on the inside of this straight edge at one end, the straight edge being 10 feet in length and the proper fall which is required for a 4-inch house drain being 1 foot in 40 feet or 3 inches in 10 feet. The straight edge when levelled on the top surface therefore gives the correct gradient, or fall, to the top of the pegs. Intermediate pegs can be levelled from the tops of these existing pegs to form the intermediate gradient line.

The method of jointing the pipes has already been explained. When about to lay them in position, sometimes 3 inches of concrete is placed in the bottom of the trench and 3-inch bricks are then laid at intervals in such positions that the pipes rest upon them. This method leaves plenty of space for the joints to be made, and the bricklayer can finish them all round with his trowel with ease. After they have been tested and found watertight, the remaining 3 inches of concrete is placed in the trench under the pipes. Great care should be taken in performing this operation, so as not to disturb the joints of the pipes, which have been recently made, on the left of Fig. 22. The same line of gradient is continued at the top of the wooden pegs, but in this case the required 6 inches of concrete is placed in the trench before the pipes are laid upon it.

When the drain is laid direct upon the concrete, a small part of it has to be removed directly under the sockets or collars of the joints, to enable the bricklayer to gain easy access to it. The top of the collars is laid centrally to a line attached to pegs, which are driven in to a position which forms the correct gradient at each end of the trench.

It should be stated that all drains inside the house or building should be completely covered with 6 inches of concrete, the bottom part being formed of square angles, owing to the construction of the trench.

When a drain is laid outside the house or building local sanitary authority's regulations stipulate that these drains should be benched with 6 inches of concrete half-way up the side of the drain. The levels of the house drains are governed by the depth of the sewer in the road, or wherever it may be. The levels are taken from this point to the intercepting chamber and from the intercepting chamber they are taken to the highest position of any trap in the drain and inspection chambers, the levels of which are governed by the nearest branch drain to them, at various points in the drain.

INTERCEPTING CHAMBERS

We will now start at the lowest end of the drain, beginning with the pipes from the sewer to the intercepting chamber. In the construction of a house drain, a hole is usually dug near the vicinity of the sewer, in which to form the intercepting chamber, and to excavate for that portion of the drain between the intercepting chamber and the sewer. The actual connection into the sewer from this length of drain will be explained later in the chapter on Sewers. When the actual depth of the sewer is defined, the fall of this portion of the drain can be determined and the foundation of the intercepting chamber can then be laid. This consists of 9 inches of concrete in depth, and the area should be at least 6 inches all round outside the external walls of the chamber; upon this can be built the chamber.

Fig. 22 is an illustration showing the longitudinal section of the intercepting chamber. After the drain on the sewer side of the chamber has been completed and constructed to the proper fall, the intercepting trap should be fixed. This is an important section in the house drainage system, and great care should be taken in fixing it properly. It should be fixed exactly level, so as not to endanger the water seal within the trap. The method of testing the water seal is to let down a piece of wire, the shape of which is shown in the diagram, until it touches the underside of the bend. It can then be lifted out and the depth of water will show on the surface of the wire.

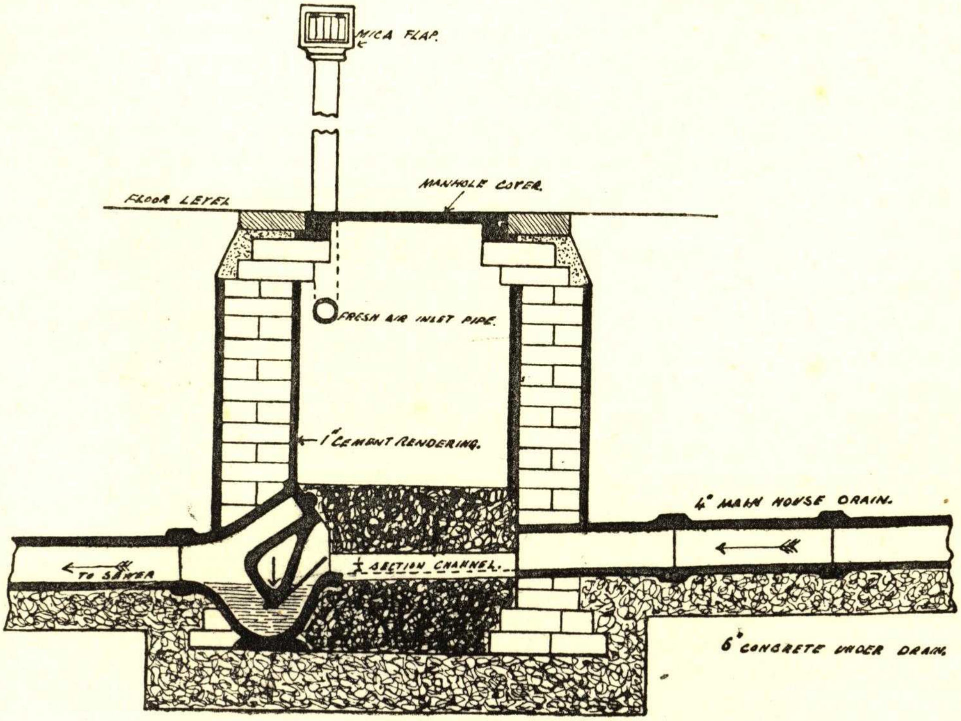


FIG. 22.

There are various methods which are used in the fixing of this trap. The trap should be bedded solid on the concrete base as shown. One way of levelling is to make a horizontal line on the trap, parallel with the bottom base line of the trap, the height being about level with the water line. This line should be on the external face of the trap. A 3-foot level can then be used by placing it against this line to level the trap. Some makers paint this level horizontal line on the traps for levelling purposes before they send them out from the works. Some intercepters are sent out from the works with a recessed level bedded in the middle portion of the trap which enables the bricklayer to level his trap easily. The point where these recessed levels are placed is shown by an arrow mark in the centre portion of the trap. The trap should have a water seal of 3 inches. It should be tested for soundness and also filled with water, to see if it is watertight before it is fixed into position. The trap should have a cleaning arm and a good composite joint in the interior face of the socket at the end of the arm, into which a stopper should fix. This also should have a composite joint. The two composite joints are splayed, and one or two turns of the stopper in the socket of the arm should ensure a perfectly tight joint to shut off any sewer gas which may escape from the sewer, and so prevent it from entering the house drain. This stopper can also be removed at times in the case of a blockage, in which case rods are pushed down the clearing arm to clear any blockage at the sewer side of the chamber. A round glass disk is sometimes bedded in the socket of the cleaning arm, with a thin layer of neat cement. These cost very little and can be broken at any time there is a blockage. They serve in the same capacity as the stopper in preventing sewer gas from entering the house drain.

Having fixed the trap, the walls of the manhole can now be constructed. The size of an intercepting chamber for ordinary house drainage is generally 3 feet long and 2 feet wide ; sometimes larger according to the various branches which are connected to it. The wall which is nearest the sewer end is governed by the position of the trap. It will be seen from the illustration that this wall is built on either side of the trap, the face of which is in a vertical line with the back part of the socket of the cleaning arm. This allows for a 1-inch rendering of cement on the face of the wall, which finishes in a vertical line with the external face of the socket. The other walls can then be set out. These are governed by the number of branches which are to be connected to the main channel before building these walls. The intercepter should be covered with 6 inches of concrete all round the sides, to keep it in a firm position. The main channel, which is a half section channel, can be bedded and levelled in to its proper fall. The length of this channel is governed by the number of branches which are to be connected to it on either side. The channel should be jointed into the socket of the intercepting trap with a neat cement joint, and finished off neatly at the angle of 45 degrees. When the number of branches has been ascertained, concrete can be placed on each side of the half section channel, and the various half sections or three-quarter sections, whichever are to be used, can be bedded in position to their proper falls into the main channels. The usual method which is used in bedding these channels is to spread a good bed of cement and sand under them, and press them firmly into it. This forms a solid bed. At the lip end of these channels, a bed of neat cement is placed at the same time at which they are bedded, and when pressed down this forms a watertight joint at this point, that is, between the lip of the half or three-quarter section branch channel, and the top part of the half section main channel. A 4-inch pipe should next be placed in position at the end of the main channel. This is jointed into the socket of the main channel with a neat cement joint. A length of pipe should also be jointed to all the socket ends of the half or three-quarter section channel bends in the various directions which the branches are to take.

Having fixed the intercepter, the main half section channel, and the various half or three-quarter section channels on either side of the main channel, and also a 4-inch pipe to main channel, the size of the chamber can be set out with the side walls of the chamber and also the wall from the branch drains at the house drain side. The side walls are governed by the longest half or three-quarter section bends on either side of the main channel. The wall on either side is built taking a vertical line for its position 1 inch back from the end of the sockets of the bends. The same position of the wall can be defined on the opposite side of the channel. If there are no channel bends, on one of the sides of the main channel, 9 inches or 12 inches is usually allowed for the purpose of forming a good benching. The wall on the house drain side of the chamber is built in a vertical line about 1 inch back from the spigot end of the house drain pipe, which connects to the main channel in the chamber. All these positions are, of course, on the internal faces of the 9-inch walls which form the chamber.

The best method in building these chambers is to construct the walls to a height about 18 inches above all the channels and connections, and then to finish the bottom portion. This is carried out by concreting the spaces between the channel bends, and benching the material by forming a sharp gradient. These various spaces, after being filled with concrete, are neatly finished off in washed sand and cement to form an impervious surface.

All chambers should have a proper benching of cement or cement and sand, which should be at a sharp curve or incline from the channels upwards. This is essential because when a stoppage occurs in the drain or trap, probably half filling the chamber with sewage, and the cause of the blockage has been ascertained and remedied, the usual subsidence will take place in the chamber, and if the benchings in the bottom of the chamber are flat, soil, etc., will settle upon the surface of it, and cause a very obnoxious smell to arise. If, on the other hand, these benchings are formed correctly at a sharp curve, the sewage will slide off easily from bench and flow into the channel, on its way to the trap, eventually finding its way into the sewer. When manholes or chambers are cleaned, these benchings, if they are correctly formed, can be cleaned more easily by the aid of a hose pipe. If, on the contrary, these surfaces are flat and the drains have not been cleansed for some period, certain splashings will have taken place from the branch drains, especially with half section channels and flat benchings.

Deposits are then liable to form on these flat surfaces, and so are much more difficult to clean than the sharp curve incline benchings. After the bottom has been finished and allowed a reasonable time to set, the whole should be covered over with boards and sacking over them. This prevents any dust and dirt from falling into the channels and trap. The boards can be conveniently placed on the top edge of the benching. This edge of the benching should be roughed so as to form a key for the vertical rendering on the walls, which eventually joints it and forms an internal angle. It is at these points that leakages generally occur when having the final water test on the drains. The boards form a platform for the bricklayer to work on in constructing the remaining portions of the chamber walls. All chambers should be built in 9-inch brickwork with cement and sand. Proportions of the materials used should be one part of Portland cement and three parts of sharp clean sand. During the construction of the remaining portion of the brickwork of the chamber, iron steps should be built in at one of the internal angles, or on the face of the end wall nearest the house drain. Flat iron is generally built in the internal angles of the wall, at an angle with the two internal faces of the wall of 45 degrees space, which should be allowed for the foot of a person from the internal angle. These steps are built in the wall at various distances apart, for the purpose of access to the manhole, the first step usually being about 9 inches above the top of the benching. Galvanised iron treads are sometimes built in on the face of the wall. These usually extend about 9 inches from the face of the wall and are of a shape which is sufficient to take the tread of the person, usually about 4 inches in width. This completed, we proceed in building towards the top of the chamber, where a point is defined for the position of the fresh air inlet. This is usually fixed in a position near the top of the intercepting chamber. As a rule, it consists of a knuckle bend or sharp bend which is built in the brickwork. The spigot end of this projects 1 inch in front of the face of the wall, and when rendered, the spigot end of the pipe finishes in the same face line as the cement rendering, which is 1 inch in thickness. These pipes lead to a position in which the head of the fresh air inlet is going to be fixed, and are all jointed in neat cement. At the head of these pipes is fixed the fresh air inlet according to position defined. It is sometimes fixed about 12 inches from the ground, and jointed in neat Portland cement to the collar of a stoneware pipe and encased in cement and sand, leaving the front part, which contains the mica flap, open to the air. At other times, the fresh air inlet is fixed into a 6-foot length of vertical L.C.C. iron pipes 6 feet from the ground line surface. This is fixed into the socket of the iron pipe, with a molten lead joint. The bottom of the iron pipe or the spigot end is fixed in the stoneware socket, and fixed with a cement joint. The latter method of fixing is the best, as one thus obtains a greater volume of air at the 6-foot height than at a level near the ground line.

The size of the cover and frame is the next consideration. Manholes and chambers which are built inside buildings have special covers. These are in the form of double-seal cover, and usually countersunk, the countersinking being filled with material which harmonises more or less with the surrounding or existing floor surface. Covers for outside purposes are made in both heavy and light patterns. These are at times countersunk and filled with various materials to match the surrounding surfaces of the roads, pavements, or forecourts, etc. All iron covers to chambers should be grooved or bolted and finally hermetically sealed by some plastic composition, the usual substance being cart grease.

The usual size of the ordinary intercepting chamber is 3 feet by 2 feet. The covers used for these chambers are generally of a smaller size, a common pattern being 24 inches by 18 inches. This means that the internal size of the chamber must be reduced, therefore we must build one or two projecting courses near the top of the manhole, to be able to bed the frame of the cover. This should be bedded in good cement and sand. The oversailing courses, as shown, are tailed down at the back with concrete, which is placed on the back portions of the bricks and holds them in a firm position. The whole of the manhole should then be rendered out on its external face, by applying 1 inch in thickness of good cement and sand. This should be well trowelled, and well keyed to the surface of the brickwork, the joints of which should be raked out for this purpose, before applying the cement rendering. This should then be allowed to set reasonably hard, and the whole of it thoroughly cleaned out, including the channels and the intercepter, before the final test is applied to it.

Fig. 23 is an illustration showing the plan of an inspection chamber. These are placed at various points of the drain for cleaning purposes and means of access, where sharp bends or changes in directions occur in the drain. This plan shows the main channel, with three branch drains connected to it on one side. All of these channel bends from these branch drains bend in the same direction as the flow. The benching is also shown. This chamber, which is near the highest point of the drain, shows the pipe on the extreme left which leads to the ventilating pipe, carried up in a vertical position against the wall of the house or building at least 3 feet above the eaves of the roof. A wire case is attached to the extreme end of this outlet pipe, so it will be seen that the fresh air is admitted into the intercepting chamber, which is at the lowest point of the drain, and travels through the drain from this point in an upward direction, finally finding its way through the ventilating pipe into the fresh air. By this method, the drain is ventilated by a current of fresh air from the lowest to the highest point of the drain. The bottom of the ventilating pipe is marked VP as shown in plan.

Fig. 24 is an illustration showing the section of the inspection chamber with main half section channel and three three-quarter section channel section bends on the side. The oversailing bricks are shown at the

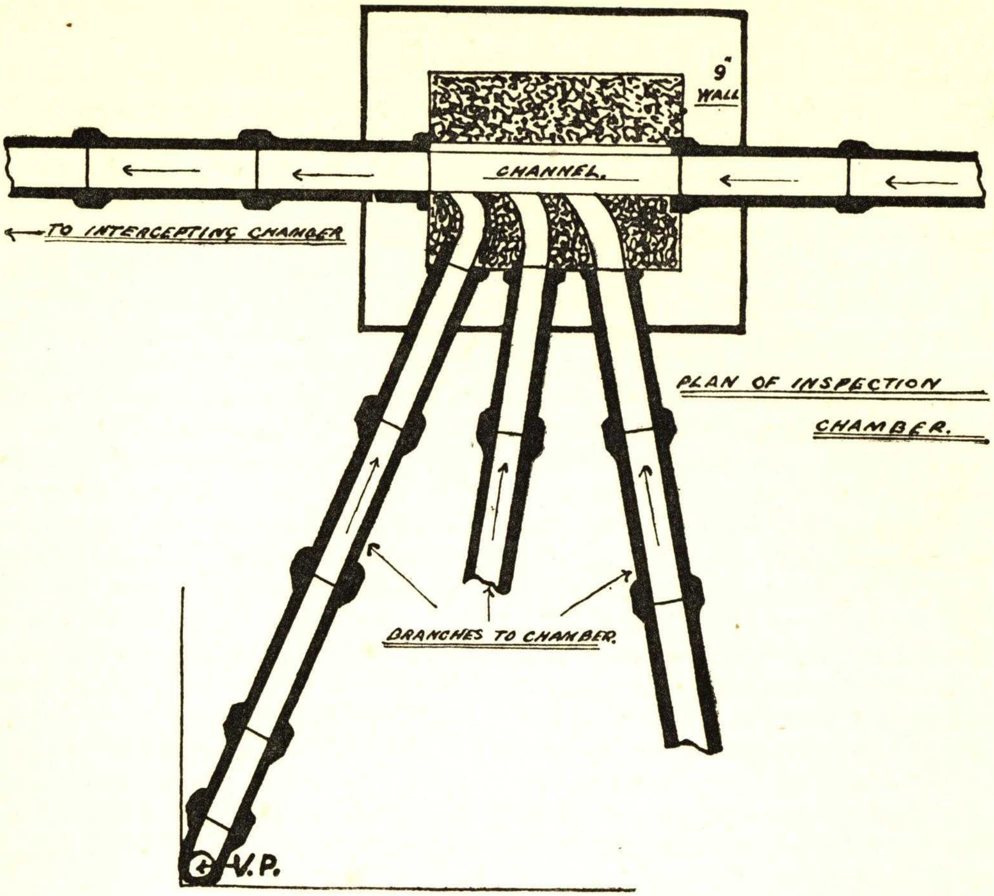

9" WALL
CHANNEL.
TO INTERCEPTING CHAMBER
PLAN OF INSPECTION CHAMBER.
BRANCHES TO CHAMBER.
V.P.

FIG. 23.

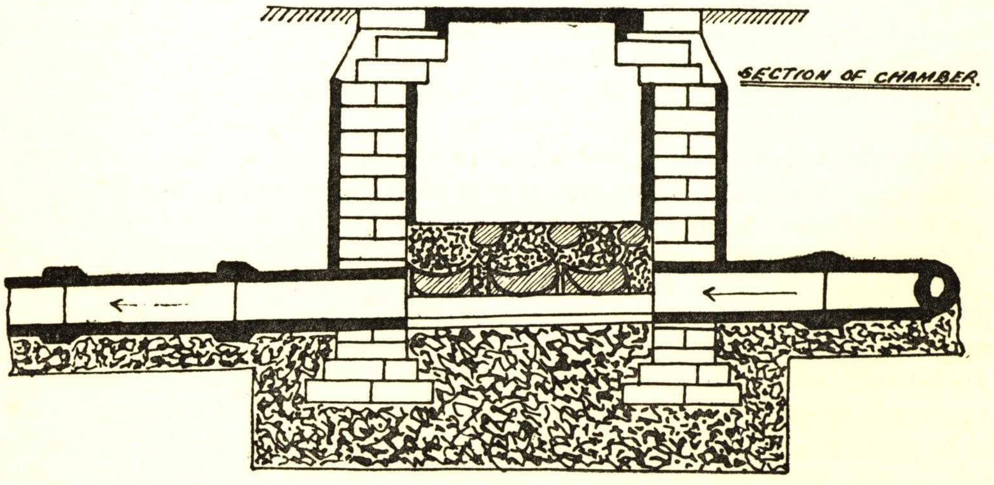

SECTION OF CHAMBER.

FIG. 24.

top portion of the manhole, in order to receive the frame, which is of a smaller size than the internal size of the chamber. This chamber is also rendered in cement. The thickness of the rendering should be 1 inch. Sometimes the external faces of these walls are rendered with 1 inch of cement, to form an external seal to ensure the chamber being watertight when the final test takes place. The benching in these chambers should be constructed in the same manner as in the intercepting chamber. No iron steps are usually required for inspection chambers, their depth being generally accessible without the use of them. The frames should be bedded level with the surrounding floors or ground line. On no account should they be lower than the surrounding ground, as they would be likely to collect a certain amount of water upon their surface, and if not swept off, would become stagnant and cause bad smells to arise.

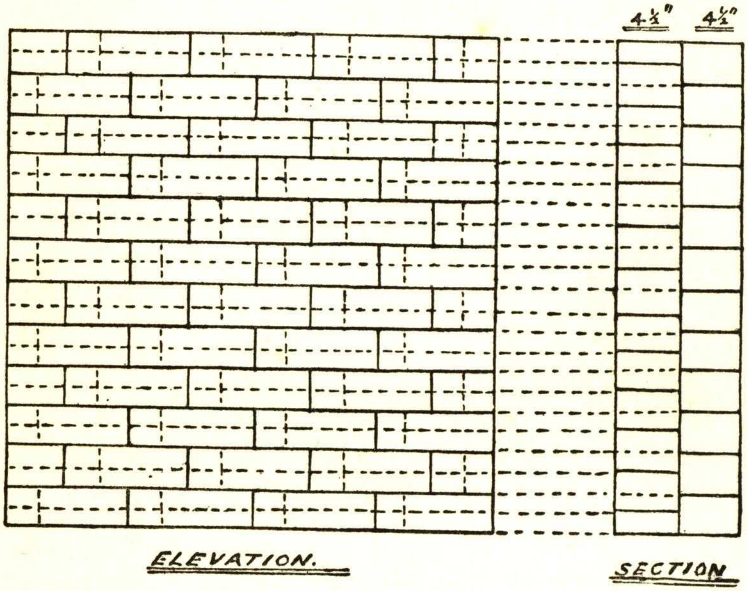
Traps and Gulleys.—The fixing of various traps and gulleys is very important. They should also be bedded level on a bed of concrete, and care should be taken in cleaning out the internal part of the pipes when the final two or three joints are made. Supposing we have set a trap in position, one which is central to waste pipe coming from a sink and level with the surrounding ground, at the lowest end at a point outside the inspection chamber the pipe which is attached to the three-quarter section bend in the interior of the manhole will be pointing in the direction and in a line centrally with the outlet of the gulley. We have to lay our pipes from this lowest pipe outside the chamber to the outlet of the gulley. For this purpose, we fix a line centrally on the top of the collar of this lowest pipe, and extend it to the outlet of the gulley. Supposing this to be a P outlet, the line should be fixed above this outlet in a central position by means of a block of wood. This 2-inch block placed on the top of the outlet allows for the depth from the top of the pipe to the top of the collar or socket. In this way, the pipes can now be laid starting from the lowest one next to the chamber, and proceeding upwards towards the gulley. All the collars should touch the line centrally as they are laid in position. All these short branch drains should be laid in straight lines wherever possible.

Clearing Drains.—As we proceed with these pipes and the last two or three pipes remain to be laid and jointed, we insert a card to which is attached a piece of rag rolled into the shape of a ball, and made to fit reasonably tight in the internal part or bore of the drain. The cord which is attached should be long enough to be pulled through these pipes, and also the trap when all the pipes have been jointed. As each pipe is laid, the string or cord is passed through the inside of it and left loose at the end until all are in position and the joints have had a reasonable time to get steady. The cord is then pulled through the trap quickly so as not to disturb any of the pipes. The ball of rag which is attached to the end of it passes through the bore of the pipes, bringing with it any surplus cement which may have gained access to the internal part of the pipes during the process of making the joints. This method thoroughly cleans the inside surface of the pipes.

When all the joints in the house drainage system have been tested, the drain should be thoroughly flushed through with clean water.

Intercepting and inspection chambers are sometimes built internally with white glazed bricks. These make a first-class drain and can be kept very clean if inspected and cleansed at regular times.

Walls of Chambers.—Walls of chambers and manholes are built in various ways to ensure their being watertight. Fig. 25 is an illustration of an elevation of a chamber wall, in which the bed joints and also the cross joints do not run horizontally and perpendicularly through the width of the wall. The bed joints and cross joints on the internal face of the wall only proceed internally from the face of the wall 4½ inches. The end of the joints butts against the centre back portion of the bricks in the external face of the wall.



FIGS. 25 and 26.

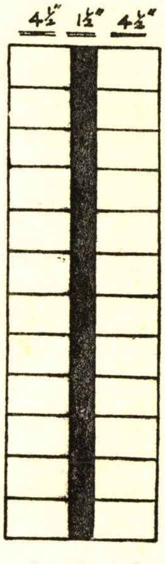


FIG. 27.

Fig. 26 is an illustration showing the section of this class of wall. In this illustration, one can see that all the horizontal bed joints are only 4½ inches instead of the usual 9 inches as in a 9-inch wall built in the ordinary way.

Fig. 27 is another illustration showing the section of a different type of wall, which consists of two 4½-inch outer walls and a middle cavity of 1½ inches, which is filled with asphalt to form a seal to ensure the chamber being watertight.

Catchpits.—Fig. 28 is an illustration of a plan of a catchpit which is used on the main line railways. These pits are built barrel shape. They are constructed at various distances along the permanent way, usually placed in the six-foot way, generally between two sets of rails. Being in this position, they have to withstand a great pressure caused by the weight of the trains on either side of the six-foot way, therefore they are segmented in shape on each side. Being of this shape, they are able to withstand a great pressure. These pits are constructed with 9-inch brickwork pointed internally and the bricks very solidly bedded. A pit is formed in concrete at the bottom and rendered with cement to ensure it being watertight.

Quality of Brickwork.—I may mention here that all brickwork in chambers and manholes should be solidly built and well flushed up each course when being constructed. In the case of sectional bond in the 9-inch wall, we have joints in the stretcher course and also in the header course which run through the whole width of the wall horizontally and vertically; therefore if loose joints are made, there is a tendency at these particular points for the water to penetrate through the thickness of the wall. Again, in glazed brickwork, great care should be taken in bedding the bricks in a solid manner, especially because we have thin joints to work to a gauge of four courses to the foot. This class of manhole is sometimes built in blue Staffordshire bricks, and if the bricks are solid, it makes a good watertight construction.

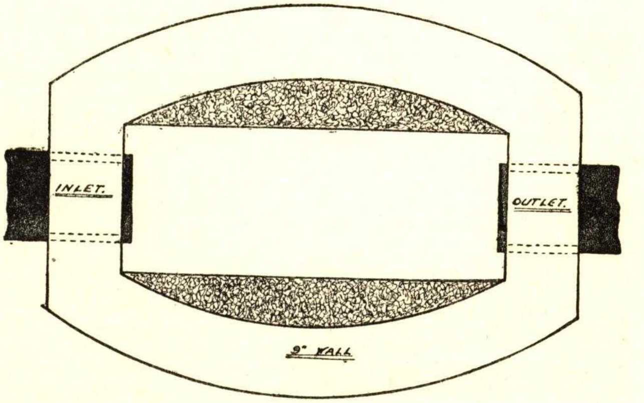


FIG. 28.

Fig. 28 shows concrete on either side of the pit, each chamber being built in the same way. This concrete forms the sides of the pit, and is built 12 inches in height at each side, which gives a foothold for the man who inspects the pits at various intervals. The outlet, as will be seen at the right end of the pit, is at a lower level than the inlet. These chambers are connected to each other by lines of 6-inch pipes throughout the length of drainage.

Before proceeding to explain the use of the intercepting trap in detail, one or two words must be said about points of access for cleaning and removing short branch drains. In drains which terminate with a gulley trap, cleaning is very awkward, therefore in some gulleys there is an access point which is formed in the gulley and brought to a level with the surrounding ground, and sealed with a cover. This cover is opened at times, and enables the cleaner to push his rods from this point direct to the main drain.

Connections with Main Drain.—Another important point is the connection of the various pipes and bends into the main drain. The channels should be so fixed that the flows from them do not materially reduce or impede the flow in the main channel.

Fig. 29 is an illustration of the three-quarter section channel connected with the half section main channel, direction of flow being indicated by the arrow mark. When the branch drain has a rather steep gradient, it is advisable to have a three-quarter section channel bend at the junction where it joins the main channel. This three-quarter section bend checks the flow of the branch drain, and therefore does not check the flow, to any extent, of the main drain. It also saves the sewage from splashing over the sides of the main channel, and prevents deposits from forming on the sides of the benching. If the channel bends are placed at right angles to the main drain, the velocity of the flow in the main drain is checked, and if the branch drain is at a rather steep gradient, the flow of sewage rebounds from the side of the main drain, and bounds back again into the branch drain, causing, at times, deposits to accumulate at this point, and in the course of time, the drain is choked.

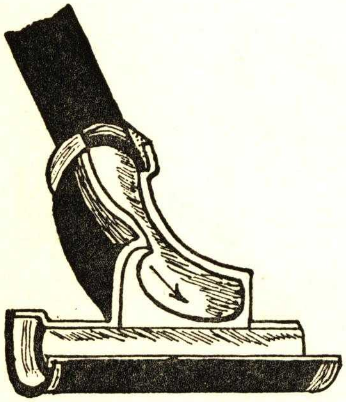


Fig. 29.

Gradients.—House drains should be of a gradient that will produce a minimum velocity of 3 feet per second. The gradient of pipes therefore should be 1 in 40; 6-inch drain 1 in 60; 9-inch drain 1 in 90.

Intercepting Traps.—One of the main fittings of the house drainage system is the intercepting trap. It is essential that the bricklayer who fixes the trap should know a few points about its use.

The intercepting trap which is in use in almost every house drainage system in London and outer London, as well as various other parts of the country, is a very essential and useful trap. It was introduced originally by the Local Government Board, and was one of the features of their model by-laws which came into being in the year 1877. A great number of these traps have been used since that time, and have proved efficient and suitable for the purpose for which they were designed. I have inspected from time to time a great number of these traps under ordinary working conditions, and in almost every case I have found them working in a perfect manner, absolutely fulfilling the various functions required of them. The original object of the intercepting trap was to prevent sewer gas from entering into the house drainage system. Thus the placing of this trap in a certain given position intercepts or divides the sewer portion of the drain from the house drain.

Fig. 30 gives a view of the section of the intercepting trap showing the main half section glazed channel which terminates at A and is jointed into the socket of the intercepting trap. The direction of flow is away from this point in main channel. At this point marked A, the sewage falls into the mouth of the trap with a cascade action over this lip or curve. The bottom of the half section channel to the water level of the trap should be 3 inches. The level of the water in the trap to the point marked with an X forms the depth of the water seal in the trap. This water seal prevents the sewer gas passing the trap and gaining access to the house drain side of the intercepter. Point B is the spigot end of the intercepter into which the socket of the first pipe is fixed and jointed on the sewer side. Point C is the cleaning arm of the intercepter. At the chamber or highest end is fixed a stopper with a patent airtight joint. This stopper also prevents the sewer gas from entering the house drain. Unfortunately, at times, this stopper may be blown out into the chamber through an excess of sewer gas passing up the cleaning arm of the trap. This stopper should be secured tightly in position after fixing the trap. Above the trap is shown the 9-inch wall, with 1 inch of cement rendering on the internal face of the chamber.

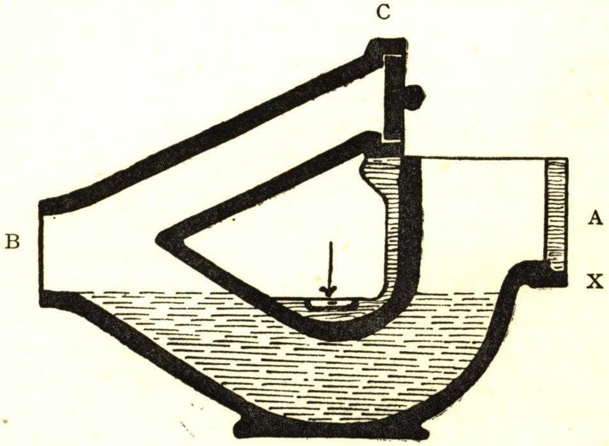


Fig. 30.

The intercepting trap should be made of the best stoneware, which should be thoroughly glazed, free from interior roughness, blisters, etc. It should be sound, strong, and of a uniform thickness, and should be free from airholes or cracks. The intercepter should be watertight and should have sufficient water in the trap to maintain the maximum water seal. There should be a cascade action when the sewage is flowing into the mouth of the trap, of 3 inches in depth. The stopper in the end of the cleaning arm should be fixed with a proper joint. The water seal should be 2 inches minimum depth. The intercepter should be the requisite size, not too large, but of sufficient dimensions to enable the contents which are in the trap to be thoroughly flushed out at each time when there is a discharge from the house drain. The 4-inch intercepter is sufficient for all the requirements of the ordinary house drainage system. If a 6-inch intercepter were used in the construction of the ordinary house drainage system, then discharges from the various sanitary fittings in the house would not be sufficient to flush out the contents in the trap each time there was a discharge from them. Therefore the trap should be well tested and examined, to see that it contains all these essential points.

The main half section straight length of channel which is fixed into the mouth of the intercepter should be well bedded and fixed to a proper fall, to maintain a proper and efficient flow of the contents which come from the house drain and discharge into the trap. This flow should be of a maximum rate to enable it to flush out the contents of the trap, and therefore keep it in a clean condition. Therefore the joints at the mouth of the trap should be finished off smoothly, coupled with the smooth internal face of the trap at this point, in order to make the action of the flow as efficient as possible. The three-quarter and half section channel bends should also be placed in the most suitable direction so as to make the main flow efficient, and not to impede it. If half section channel bends are used, proper benching should be formed to the right curvature in the direction of the flow. All these points are essential to obtain the maximum efficiency of the required flow of sewage from the house drain to the trap.

Stoppages in Drains.—Stoppages in drains may be caused in various ways. (1) Bad jointing to pipes will eventually cause a stoppage in a drain. This is due to bad workmanship in not thoroughly cleaning out the internal portion of the drain. If these joints are not thoroughly cleaned out and made smooth in the bore of the drain, and are left ragged, by which I mean small portions of cement are left projecting from the internal face of the pipe, these small ragged pieces naturally impede the flow each time hard material flows through the drains (such as paper, etc.). These substances at times are caught by these ragged edges of cement, and gradually accumulate around these points, thereby impeding the flow, and in course of time causing a complete blockage in the drain. (2) An insufficient fall in a drain, which would cause a very sluggish flow, will cause the solids to settle in the drain, in which case they gradually accumulate and eventually cause a stoppage. This again is due to the bricklayer not securing his proper levels, and the correct fall of the drains, before laying them in position. (3) Again, in mixing the cement for the jointing of the pipes, very often the cement is made too soft when placed in the collars of the pipes which are to receive the spigot ends of the pipes following them, which causes the spigot ends of the pipes to drop downwards in the socket of the pipe a little below the invert of the preceding pipe, thereby producing a ridge. These ridges impede the flow of sewage, and pieces of solid matter will eventually accumulate at these points, and in the course of time bring about stoppages. This is also due to inefficient workmanship, which could be prevented with a little care as in the two previous cases. The intercepting trap gets blocked at times, but the trap itself cannot be blamed for these causes. I have known cases where, after the drains have been tested and finished, there has been a blockage. After a thorough inspection, it has been found that the blockage was caused by a deposit of cement or concrete in the bottom of the intercepting trap left there by a careless workman who did not thoroughly clean out the trap. Various solid matters gradually accumulated at this point in the trap, and it soon became choked. (4) A stoppage may be caused by using a large intercepter where a smaller one would be efficient for the purpose. In the case of the large one, the flushes from the house drain would be insufficient to flush out the contents of the trap effectually, and so a certain amount of solids would accumulate at each flush, and choke the trap. If the smaller one were used, it would perform all its requirements efficiently. Of course, there are various other causes; for instance, there are cases where careless servants let various articles such as small brushes, floor cloths, etc., find their way into the drains. These find their way to the intercepting trap, and in course of time this causes a stoppage. (5) Drains which are too large in diameter where smaller drains would do the work efficiently. The large drain in this case would not be self-cleansing like the smaller one, there being an insufficient flow to cleanse the bore of the large drain, therefore accumulations and eventually stoppages. (6) Sometimes the intercepter is blocked by the stopper of the cleaning arm which has been blown out by an excess of sewer gas. But this very rarely occurs if the stopper is properly fixed in position. Sometimes the roots of trees gain access to a drain through a leaky joint, creep into the bore of the drain, and, in time, grow to such an extent that cases have been known where these roots completely block the whole bore of the drain.

Testing Old and New Drains.—The bricklayer should be able to test the drainage of a house when completed or know how it should be done.

All new drainage systems should be properly tested with water before they are covered in. The testing and the passing of the drains proves that they have sustained the test required by by-law No. 4 of the London County Council and rests with the Sanitary Inspector or Surveyor attached to the local sanitary authority. In rural and urban district councils, it rests with the Inspector of Nuisances attached to the local sanitary authority.

The testing of new drainwork is generally carried out by the hydraulic or water test, or the pneumatic or air test. Old drainage is usually tested for leaks, etc., by the smoke test or by the chemical or scent test.

The test usually applied on all new drainage constructions in London and the suburbs is the hydraulic or water test. The method of testing is by plugging the drain with a bag or stopper. This is shown by the illustrations in Figs. 31 and 32. Fig. 31 shows the bag inflated and in position in the pipe. A hand pump is attached, at the end of which is a tube also attached to the rubber bag. The point at which this bag is inserted is at the lowest point of the house drain. This is the first pipe on the house drain side which leads from the intercepting chamber. The bag is placed in position in this pipe in its loose condition, and then inflated in the pipe with the aid of the air pump. This completely fills the bore of the pipe, and makes it watertight. The whole of the drains should then be filled, including all gulley taps, branches, W.C. pans, etc. W.C. pans are usually filled and a stopper inserted at the end of the branch to which they are attached, that is, the nearest inspection chamber to them. These are sometimes tested separately with other small branch drains, and when the final test takes place, the water is generally filled in up to the level of the top of the lowest gulley trap. This nearly fills the inspection chambers which are in close proximity to them. Care should be taken with the gulley traps which form the terminating points to branch drains, etc., to make sure that the air is withdrawn from the crown of the bend or outlet. The air should be removed from these points in order to make a good test.

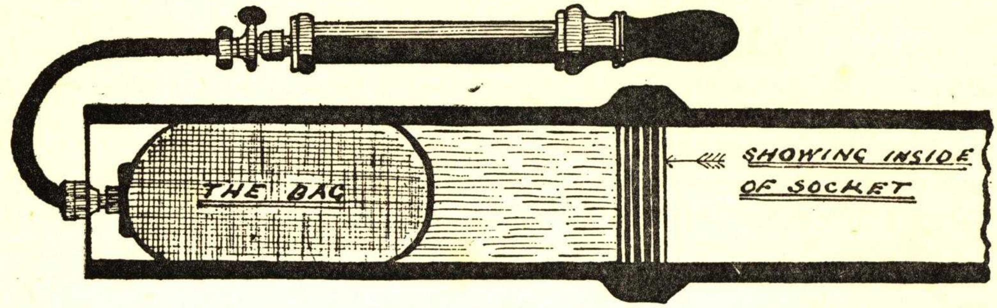


Fig. 31.

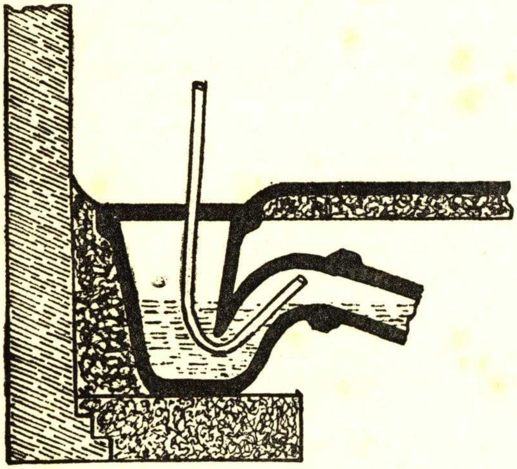


Fig. 32.

Fig. 32 gives an illustration of the method which is employed to remove this air in the crown of the outlet bend. This is done by inserting a flexible piece of rubber tubing into the top of the trap, the end of which should be bent under the water seal, and just come up above the water level into the air pocket. The surplus air can then be withdrawn from this point by drawing the air through the pipe. This pocket of air can then be filled up with water and the top of the water level in the final test will stand at a level with the top of the gulley trap. If the intercepting chamber has to be filled as well in the final test, this is often done by fixing an access pipe on the sewer side of the chamber, and inserting a bag at this point. This enables the intercepting chamber to be completely filled with water. The water level in the intercepting chamber is generally about three or four feet down from the level of the surrounding ground level, which is marked and should stand for about an hour. If the water in the chamber does not subside in this period, it can be passed.

Fig. 33 is another way which is used for plugging the drains for testing purposes. This is an illustration of the 4-inch drain stopper. These are made in various sizes, 4 inches, 6 inches, 9 inches and so on, according to the size of the drain into which they are to be fixed. The bag is more convenient to carry than the stopper, especially where you have a number of branches which have to be tested at the same time. The plug or stopper consists of two metal disks, circular in shape, which are attached to a metal tube. One disk is secured to the tube, and the other fitted loosely around it. Between these two disks there is a cylindrical rubber bag which is fitted into the rims of the two circular disks. At the top of the tube a thumbscrew is fixed, which runs on a thread made in the metal tube. This draws the two metal circular disks together, and compresses the circular rubber bag, which enlarges in circumference, and in doing so, fits tightly into the bore of the pipe. The stopper is usually inserted into the pipe which is to be tested in a loose condition, the two disks being apart. When in its position in the internal part of the pipe, it is screwed up tightly, and the rubber band expands to the internal bore of the pipe, which is then ready for testing. A cap is sometimes attached to the end of the metal tube, which can be screwed on and off.

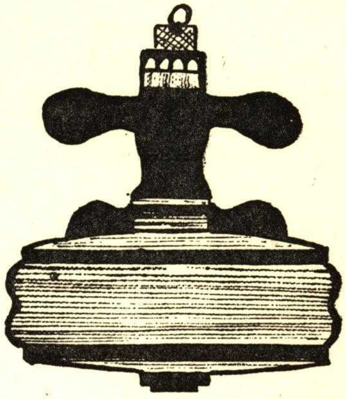


FIG. 33.

When the final test has taken place, there is a considerable pressure of water against the stopper in the pipe. This cap can then be removed and the water extracted gradually through the tube. The stopper can eventually be removed when the pressure of water is less, and all the water drained from the pipes.

A drain is usually expected to withstand a pressure of at least two feet of water. For the smoke test, a smoke-making apparatus is used in connection with the bag or disk stoppers; and for the scent test, peppermint is generally used.

BY-LAWS

Every intercepting chamber or inspection chamber which is built in the metropolis must comply with the following by-laws made by the London County Council. They must be constructed so as to be watertight up to the level of the adjoining roadway or ground surface (that is, the ground surrounding them). Means of access to a drain is also a compulsory by-law. " Every person shall, except in cases where the means of access to be provided in compliance with the preceding by-law shall give adequate means of access to such trap, provide a separate manhole or other separate means of access to such trap for the purpose of cleansing it."

The next by-law is also compulsory and applies to the manhole or chamber in relation to its being watertight and airtight. By-law No. 6 : " Any person erecting a new building shall cause every means of access provided in compliance with any of the foregoing provisions of these by-laws to be constructed so as to be watertight up to the level of the adjoining ground surface or roadway, and to be fitted with a suitable manhole cover, and if placed within a building to be fitted with an air-tight cover."

The next regulation also applies to the bottom portion of the manhole or chamber in relation to the position of the connections of the branch drains at the point where they join the main drain. By-law No. 7 : " A person who shall erect a new building shall not construct the several drains of such building communicating with a sewer in such a manner as to form in such drains any right angled branch drain or tributary drain to join another drain obliquely in the direction of the flow of such drain, and as near as practicable to the invert thereof."

CHAPTER II

EGG-SHAPED AND CIRCULAR SEWERS

Systems of Sewerage—Sewer Pipes : Stoneware ; Salt-glazed or Vitrified ; Concrete—Construction of Sewers—Bonds—Building the Egg-shaped Sewer—Building the Circular Sewer—Salt-glazed Stoneware Rings—Manholes.

THE main sewers in London and most towns in England at the present time are usually constructed in brickwork. The old brick sewers or barrel drains were of a circular shape, but the sewers which are now laid are of an egg shape, while the smaller tributary sewers are formed of glazed stoneware pipes, varying in diameter according to the amount of waste they are required to take. These tributary sewers are also often formed in reinforced concrete, but are similar in size and shape to the glazed stoneware pipe sewer.

The size of main sewers is generally governed by the extent of the area which is to be drained, and in conjunction with this the population of the area which has to be dealt with has to be taken into account. Other factors are the position and the rainfall.

These points need not for the moment concern the bricklayer. They are, in fact, subjects which the engineer has to study before starting the construction of the sewer. The main object of this chapter is to explain the essential points which are necessary in the actual construction of a good sewer.

Systems of Sewerage.—There are three systems of sewerage, known as the separate system, the combined system, and the partially separate system.

The separate system comprises two sewers, one taking the sewage, and the other taking the rain-water.

The combined system consists of a single sewer which takes all the house sewage and waste, rain-water and surface water.

The partially separate system comprises two sewers as in the separate system, with only one set of drainage to the building and these discharge into the foul sewer which takes the sewage.

Sewer Pipes.—Small sewers, as already stated, are constructed of stoneware pipes, the clay of which they are made being impervious when properly fired. The pipes made from this clay are of two kinds, stoneware and vitrified clay. The stoneware clay, which is obtained from Devonshire, is mixed with powdered flint before being fired and prepared for use. Vitrified clay is composed of fireclay and is mixed with sandy loam thoroughly mixed together and the moulded pipes fired at a very high temperature, being salt-glazed or vitrified in the process. *The stoneware pipes* are made in 2-foot and 3-foot lengths, the diameters varying from 6 inches to 24 inches. These pipes will stand an internal pressure of about 200 lb. per square inch. *Vitrified pipes* are about $\frac{3}{4}$ inch thick in the 9-inch diameter pipe, and the other sizes are made thicker than the same sizes in the stoneware pipes. These pipes will resist a pressure of 2,000 lb. per linear foot.

The concrete pipes are composed of cement, sand, granite chippings, etc., and are sometimes reinforced with iron bars throughout their length, or reinforced with iron rings round the circumference of the pipes.

The materials used in the construction of a sewer should be of a good quality.

For main sewers, the bricks should be well burnt, uniform in shape, and impervious. The cement used should be of a specified British standard. The glazed stoneware pipes used in tributary or branch sewers should be of a good make from a reputable firm. They should be well burnt, thoroughly glazed, impervious, uniform in bore and thickness, straight longitudinally and free from any flaws, cracks, blisters, especially on the internal surface of the pipes.

All sewers, that is, those which are constructed in brickwork, and also those which are made of other materials such as glazed stoneware and concrete, should be laid in straight lines as far as possible, between all points of inspection. The manholes should be placed at points where the sewer changes its direction, such as the junction points in the main sewers and points where the branch sewer enters the main sewer. All sewers should be laid to a proper and efficient gradient, according to the amount of sewage which flows through them, and all tributary sewers connected with the main sewer should be constructed in such a manner so as not to impede the flow of sewage in the main sewer, by being formed in easy bends or angles in the same direction as the main sewage flow. All sewers should be ventilated at various points.

Construction of Brick Sewers.—These are constructed by two methods. The first construction, being of an egg shape, is sometimes built wholly with bricks and sometimes built partly in concrete and partly in bricks. The second construction is circular in shape, and built in rings of brickwork according to size. The small sewers or branch sewers, being usually formed of glazed stoneware pipes, are jointed with a Portland cement joint. The egg-shaped sewer is mostly used where the flow of sewage is intermittent, because it has a great hydraulic advantage, having also a greater depth of flow compared with the same volume of sewage in the circular sewer, and therefore has greater self-cleaning properties. The only disadvantage of the egg-shaped sewer is that structurally it is not so strong as the circular sewer, and is probably much more expensive to construct. The circular sewer is suitable in many instances where there is a constant flow of sewage, which will thoroughly cleanse the sewer in its flow. Fig. 34 is an illustration of the circular shape of sewer, showing the depth of the flow of sewage, the diameter of which is twice the radius as shown. Fig. 35 gives a view of an egg-shaped sewer of the old type, the top portion being a semicircle of the radius R, the depth being one and a half times the length of the greatest horizontal diameter, or three times the radius of the top semicircle. The extreme bottom portion is formed by making a circle, the bottom curve of which forms the invert. This small circle has a diameter of half of the radius of the top semicircle 4/2, or a radius of one-fourth of the top horizontal radius of the semicircle. The two side curves have a radius as shown at the point which is at the left extreme end of the top horizontal dotted line, which reaches in length to the right hand side curve of the egg-shaped sewer. This radius equals three times the length of the top horizontal radius which forms the semicircle.

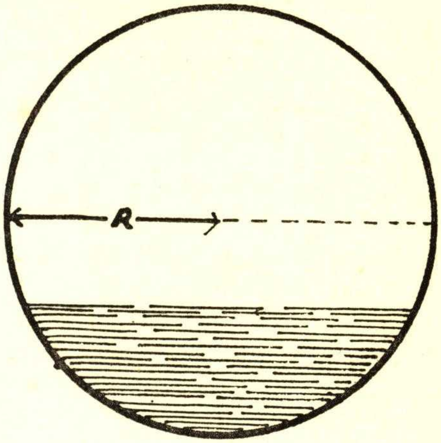


FIG. 34.

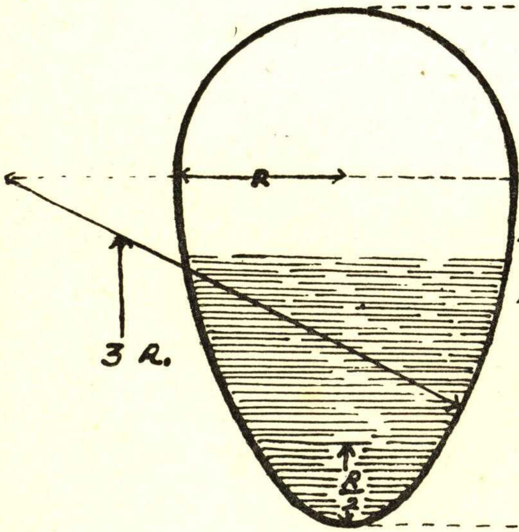


FIG. 35.

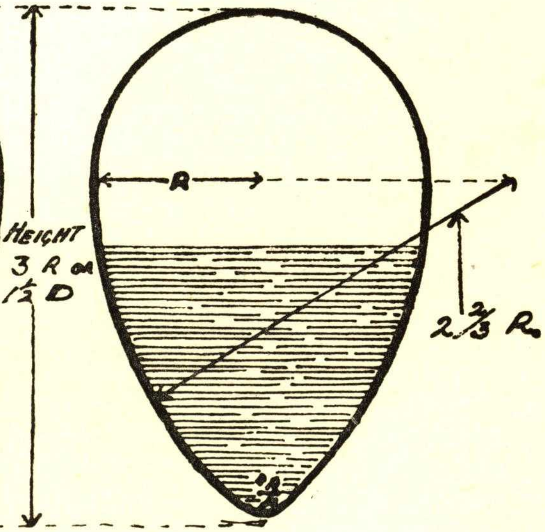


FIG. 36.

Fig. 36 is an illustration of the new type of egg-shaped sewer. The diameter of the top semicircle is the same as in the old type, while the height of the sewer is also the same as in the old type. But the radius which forms the two side curves is different, the length in this case being

2⅔ R, that is, 2⅔ the length of the top horizontal radius, which forms the semicircle. The invert at the bottom is also formed with a small circle, the bottom of which forms the invert. The radius of this circle is R/8, the diameter of which is R/4.

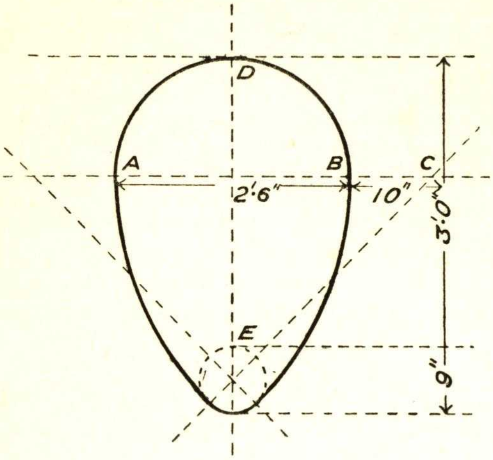


Fig. 37.

Figs. 34 and 35 show the sections of the two sewers, the circular and the egg-shaped. Both these sewers have the same sectional area, and both show the same volume of water. The depth of the flowing sewage in the circular sewer, as one can see, is much less than the depth of the flowing sewage in the egg-shaped sewer, therefore the egg-shaped sewer having the greater depth of the two; and this depth also giving a greater cleansing area and a greater velocity of flow with the same volume flowing through each sewer, the egg-shaped is decidedly the more self-cleansing of the two types.

Figs. 37 and 38 give views of the new and old types of sewers. In these diagrams figured dimensions are given for striking out the two forms.

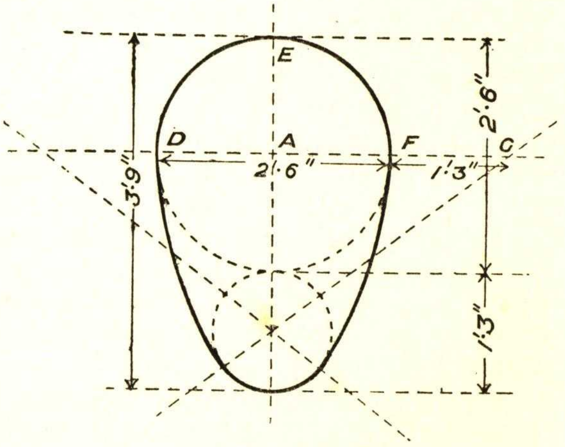
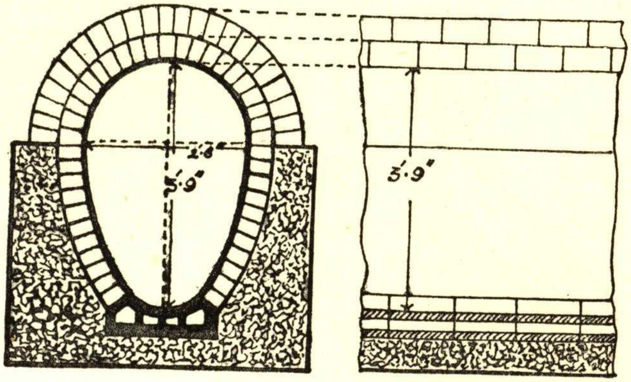


Fig. 38.

Fig. 39 shows the construction of the egg-shaped sewer. The top semicircle is formed of two rings of brickwork, while the bottom portion is formed of one ring of brickwork laid on an invert base formed of a terra-cotta block. This brickwork ring and terra-cotta block are surrounded by concrete. When building a sewer of this description, the levels are generally given and points made to work to. For instance, a series of pegs can be driven into position at points showing a level at the centres of the invert blocks, that is, at the centre invert point of the terra-cotta blocks. Then a line can be stretched from one peg to another at the points, which determine the fall of the sewer. These lines can be stretched in 6-foot lengths along a considerable length of sewer. Concrete should be first placed into position to receive the beds for these blocks to be laid upon. These can then be laid centrally to the line and properly jointed as each block is laid in position. The two shaped curved sides of the concrete are then placed into position. This can be done by fixing curved shaped shuttering along each side of the sewer trench. When the concrete is reasonably hard and set the shuttering can be removed. This is the best method of construction. If the concrete is thrown in after this ring of brickwork is completed, there is a danger of the weight of the concrete pushing against the brickwork ring and misplacing or bulging the brickwork.

This ring of brickwork can now be constructed from the terra-cotta blocks upwards to the springing of the semicircle upwards. Naturally this brickwork ring can be constructed at various points along the length of sewer which is to be constructed by means of templates of the same shape as the internal curve of the sewer, using them in the same vertical manner as the plumb rule and bob. Brickwork about 3 feet at the base and racked back to a reasonable height can be built in this manner at different points along the sewer, and the intermittent spaces can then be filled in, working to a line after the first portions have been worked to the curved template. In this way the bottom portion of the sewer can be constructed quickly. All the bricks should be well wetted, and laid solid upon their beds against the concrete. The cross-joints should be made solid the whole width of the brick when placing the joint at the end of each brick with the brick trowel.



Figs. 39 and 40.

Bonds.—The bond generally used in this class of work is half bond, the bricks being all whole bricks, and all the courses showing a stretching course. Sometimes special wedge-shaped bricks are used in the construction of sewers. Blue Staffordshire bricks, bedded in a good composition of cement and sand, make a good type of sewer.

Building the Egg-shaped Sewer.—The top rings should now be constructed. These are formed on a wooden centre, semicircular in shape, the base of which is fixed in a level horizontal position as shown in illustration by the dotted horizontal line, which forms the base of the semicircle. This is held in position by two upright struts from each side of the base of the wooden centre to the invert at the bottom, and wedged in between by a horizontal strut. These bricks, which form the first ring, and are usually of a wedge shape, give parallel joints between all other bricks. The inside ring all round the egg-shaped construction is formed with blue Staffordshire bricks, which should be solidly bedded so as to keep the sewer as watertight as possible. The top part of the egg-shaped construction, which forms the first semicircular ring of bricks, should be bedded and laid evenly on the surface of the centre. The joints should be recessed ½ inch back from the internal face of the arch, so that when the bricks are pressed tightly together in forming the arch ring the material which forms the joints will be pressed down and the outside of it will form the same face as the brick on either side of it. If the joint is made full before being pressed or tapped into position, the material will squeeze out in front of the face of the brickwork or the faces of the bricks, and when the centre is removed this material will have to be removed from the face of the bricks. In doing so, especially if some time has elapsed before the centres are removed, the material having set hard in removing it the faces of the bricks are liable to be chipped in the operation.

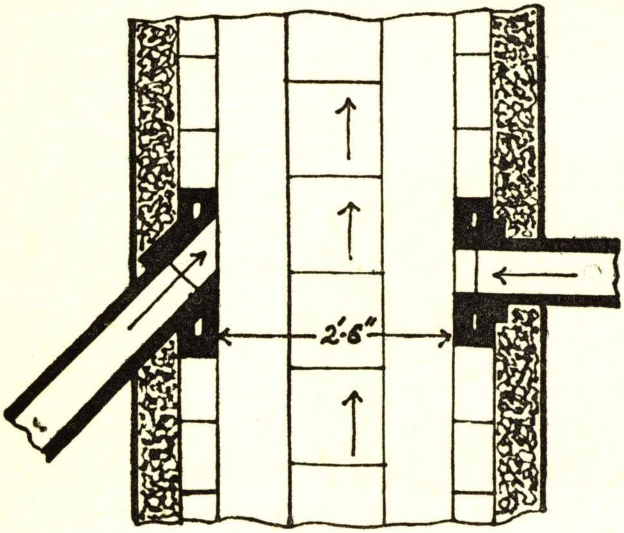


Fig. 41.

The outer ring, as shown in the illustration, is usually constructed with good hard burnt bricks and thoroughly grouted in with cement and sand.

The measurements are shown in this diagram. Height 3 feet 9 inches from the invert to the intrados of the semicircle, the greatest horizontal diameter being 2 feet 6 inches.

Fig. 40 is an illustration showing the longitudinal section of the egg-shaped sewer. The two rings of the top portion of the sewer, which is a semicircle, are shown as all stretchers. The springing line of the semicircle is also shown together with the invert and concrete beneath it.

Fig. 41 shows a plan of the egg-shaped sewer, and two branch connections running into it. The left hand connection is a good one, running at an angle in the direction of the flow in the sewer. The right hand connection is a bad one, and should not be allowed as it runs in a right angle direction into the sewer ; in doing so, it retards the flow of sewage in the sewer. The connection should be made at a point as near as possible to the springing of the semicircle. The width between these two connections is 2 feet 6 inches.

Building the Circular Sewer.—Fig. 42 is an illustration of the circular sewer. These are sometimes constructed with one ring of brickwork and surrounded with concrete, and sometimes constructed with two brick rings. These are generally formed in two parts, the bottom half being constructed with a half-round template of semicircular shape, concrete being formed of the necessary shape to receive this bottom portion as in the egg-shaped sewer; the top portion is formed on the centre by the same method as the egg-shaped sewer. They are generally constructed with a diameter of 2 feet 6 inches. The joints should all be solid and the same method used in the top portion as that used in the egg-shaped sewer.

Salt-glazed Stoneware Rings.—Sometimes the inner rings of the egg-shaped sewer are formed with salt-glazed bricks. At other times they are lined half-way with these bricks, and the top semicircular portion consists of pressed bricks specially made for sewer construction work.

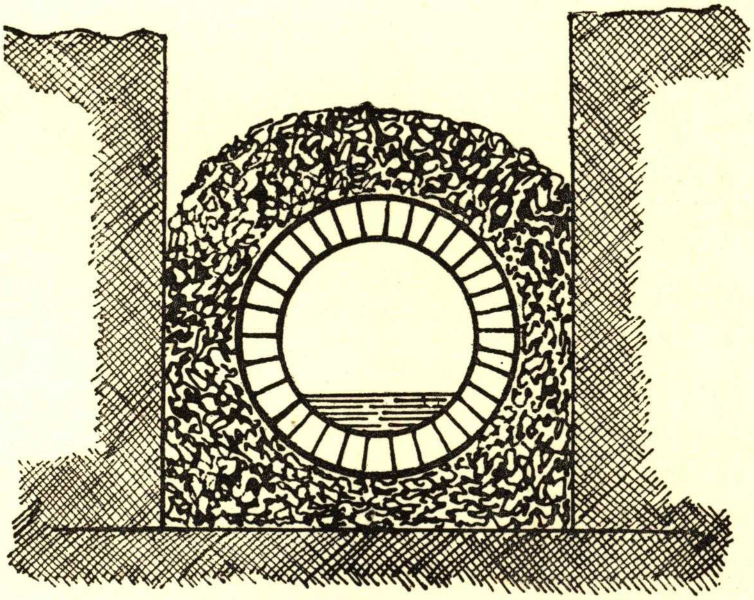


FIG. 42.

Manholes.—Sewers should be laid in straight lines between the points of inspection. Manholes should be placed at these points and also at points where the sewer changes its direction.

Manholes to sewers are sometimes built circular in shape. These are stronger than the square or oblong shape more commonly built. The circular manhole resists the pressure of the surrounding ground better than the ordinary oblong shape.

Fig. 43 gives an illustration of a section of a manhole which contains an 18-inch diameter pipe sewer. The walls are built in 9-inch brickwork, having the usual two courses of footings at the base of them.

A section of the 18-inch diameter sewer pipe is shown at the bottom of the manhole, and the concrete at the bottom and sides of it. Blue bricks are placed at each side of the pipe which forms the benching. This section of the manhole is 2 feet 7½ inches in width as shown, and 11 feet in depth from the top of the cover to the invert of the pipe. At a position near the top of the manhole, two stone plates are placed in position to reduce the area of the manhole to the size of the cover. A heavy iron cover is bedded on this portion, the top of the cover being in a horizontal line with the level surface of the road. The two arch rings of brickwork are shown, the dotted-line portion of the arch being hidden in the two side walls. Outside the two 9-inch walls of the manhole is placed a layer of puddled clay. This is to ensure that no water shall find its way to the sides of the manhole. Outside of this is the ordinary earth. The water is shown flowing at a low level in the pipe.

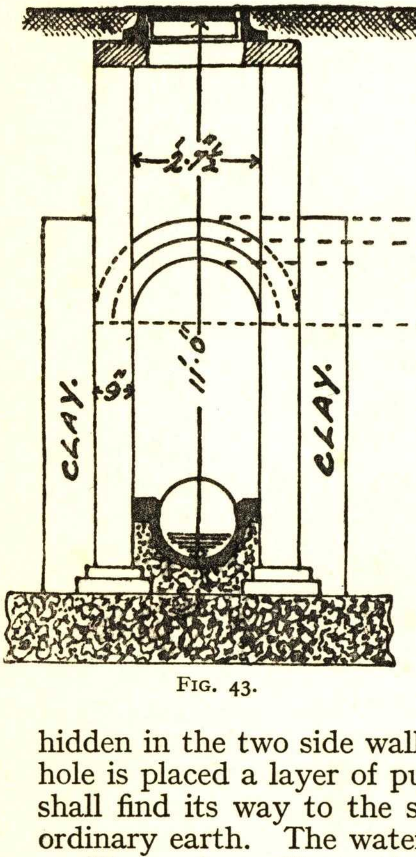


FIG. 43.

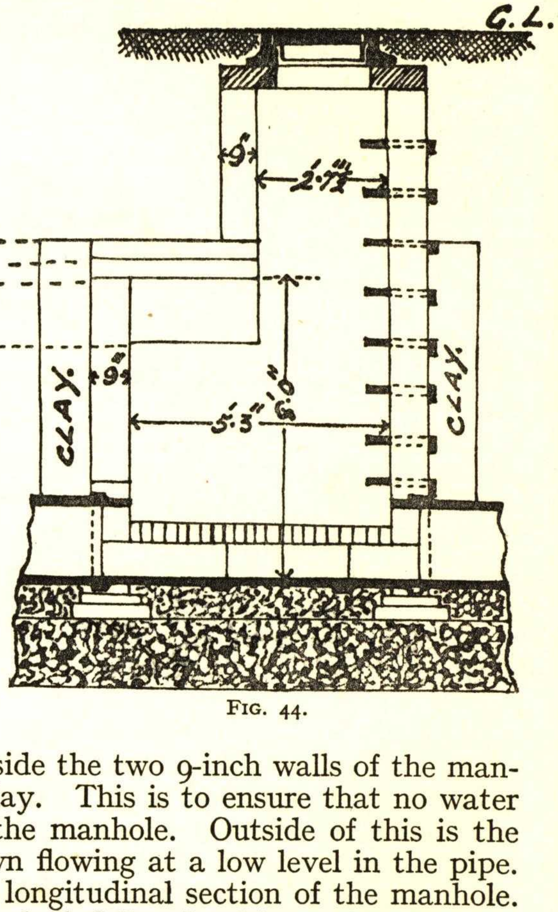


FIG. 44.

Fig. 44 is an illustration of the longitudinal section of the manhole. The ground level at the top is marked G.L. In this section the iron steps are shown, which are built into the wall at regular intervals, and turned or bent at a point on the back of the 9-inch wall. This keeps the irons firm, and saves them from drawing out of the wall. The bottom and top widths are given as 5 feet 3 inches and 2 feet 7½ inches. Thus the bottom is much larger than the top. This enables the man who cleans the sewers to work his rods with ease. The springing point of the arch is shown in this section by a horizontal line which is extended by a dotted horizontal line from the previous section. The three horizontal lines at a higher level show the section of the two arch rings which are also an extension of the dotted horizontal lines from the previous section at these points. A 9-inch wall is built above this arch and forms one of the sides of the manhole at the higher portion of it. The half-section channel which runs through the manhole longitudinally is shown, and the blue bricks which form one side of the benching are also shown. The 18-inch sewer pipe is shown at either end of this half-section channel with the concrete below them forming the bed for these pipes, and also the foundations for the footings and walls.

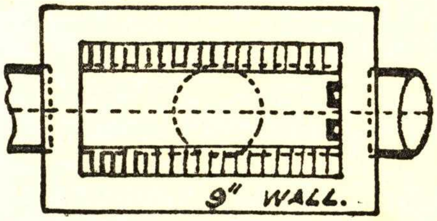


FIG. 45.

Fig. 45 shows the plan of the 18-inch sewer pipe manhole with the 9-inch wall, the 18-inch pipe at each end of the manhole, and the plan of the step irons at the right hand end of manhole. The half-section channel (glazed) is shown by the two horizontal lines inside the manhole, and the horizontal dotted lines which run parallel to them are the outside lines which indicate the thickness of the half-section glazed channel. The benching which is placed on either side of the channel pipe, consisting of blue bricks, covers the outside line of the channel.

CHAPTER III

SANITARY LAW RELATING TO SEWERS

Metropolis Management Amendment Act—Partial Construction, Addition, or Alteration —Urgency Cases—Provincial Sanitary Requirements.

It is essential that the bricklayer who executes, or is in charge of, drainage work should know something about the administration of the Sanitary Law in London and the provinces, and the procedure to be observed when submitting various drainage plans to the Sanitary Authorities.

The chief administrative body at the present time is the Ministry of Health. This department issues a set of Model By-laws, which the various Sanitary Authorities in the country take as their guide when framing their by-laws for sanitary administration. These by-laws which the local Sanitary Authorities frame must be sanctioned and passed by the Ministry of Health.

London is divided into a number of Boroughs and each Borough directly administrates its own sanitary matters. The sanitary work of each Borough is under the supervision of the Medical Officer of Health or Chief Sanitary Inspector, and these officials are held responsible for the sanitary condition of their various areas.

The construction of drains in London comes under the by-laws made under the Metropolis Management Act, 1855, which deals with the construction and ventilation of drains. The Public Health (London) Act, 1891, deals with water closets, cesspools, etc.

There is another Act, The Metropolis Management Amendment Act, 1899, which lays down rules for the submitting of drainage plans.

METROPOLIS MANAGEMENT AMENDMENT ACT

We will first deal with the by-laws of the Metropolis Management Amendment Act, 1899. The by-laws under this Act require the deposit of plans and sections of drains to the various Borough Councils in London and are as follows:

By-laws in relation to drainage plans made by the London County Council under the Metropolis Management Acts, Amendment (By-laws) Act, 1899:

CONSTRUCTION OF A DRAINAGE SYSTEM AS A WHOLE

1. The by-laws require every person who is about to construct a drainage system, as a whole, shall deposit in duplicate with the Sanitary

Authority of the district at their office, plans, sections, and particulars of the proposed construction to enable such Authority to ascertain whether such construction is in accordance with the Acts which relate to drainage work.

2. He shall cause such duplicate plans and sections to be clearly and indelibly made on durable material to a scale of 16 feet to 1 inch (except in the case of block plans). The person shall show all the floors of the building on the section, with the connection of pipes to be used. The position, level, and the arrangement of the building including the roof, also showing the position of windows and height and position of chimneys, within a distance of 20 feet from the open end of the soil pipe, or ventilating pipe. The size and position of every drain, gulley, waste pipe, soil pipe, manholes, rain-water pipes, ventilating pipe. He shall show the position of every bath, water closet, lavatory basin, urinal, and also show the position of drains which pass under the building.

3. He shall also deposit in duplicate with the Sanitary Authority of the district a detailed description in writing of the method of construction. He shall also deposit a block plan of the premises upon which any such building is situated or any such work is to be carried out.

This should be drawn to a scale of not less than 22 feet to the inch.

The block plan should be shown of such building.

The positions of the whole of the buildings on the property, and the positions of any buildings on adjoining properties which would be affected by the proposed construction of the work.

The names of the streets or roads adjoining the premises, and the number and designation of the premises.

The variations in the lowest level of the building or lowest floor and the pavement.

The level of any yard, area, forecourt, or open space belonging to the premises.

The depth, lines, and inclination of the proposed drainage, and the lines, depth, and inclination of the old existing drains or surface drains. If proposed drains or existing drainage is in connection with a building arrangements should be made to keep the old existing drains and the proposed new drains distinct from each other by using different colours for each on the drawings; this should be distinct on plans.

The position and form of every existing or proposed manhole, intercepting trap, bend, gulley, or junction, or any connection with the sewer.

Points of the compass should be shown on the plan.

Plans, sections, and all particulars shall be so deposited 15 days before the work is proposed to be commenced.

PARTIAL CONSTRUCTION, ADDITION, OR ALTERATION OF A DRAINAGE SYSTEM

Every person who shall make any addition or alteration to any existing drainage system, shall cause a deposit to be made of only such plans and sections and particulars of the proposed partial construction, addition, or alteration, as may be necessary to enable the Authority to ascertain whether such addition, partial construction, or alteration is in accordance with the Acts and by-laws relating to drainage. In this instance, partial construction, addition, or alteration to drains must be in accordance with the by-laws made under section 202 of the Metropolis Management Act, 1855.

If the plans and sections have previously been deposited in conformity with No. 1 By-law, it will be sufficient for him to give in writing, with the deposit, the date when the previous deposit of plans and sections was made, and to show the new work on the plans and sections to be deposited, and only so much of the existing work as will enable the Sanitary Authority to see the relative positions of the old work and the new.

ALTERATION OF DRAINS IN CASES OF URGENCY

In the case of drainage where it is necessary to carry the operations at once, the person shall send forthwith to the Sanitary Authority of the Borough, in lieu of depositing plans and sections and particulars referred to in by-laws, a notice in writing of the proposed alteration. He shall also, within two weeks of the commencement of the alteration, make the deposit of plans, etc., as required by these by-laws.

In the City of London, plans and sections of drainage are submitted to the City Corporation.

The above by-laws shall not extend to the City of London.

PROVINCIAL SANITARY REQUIREMENTS

These are based on the Public Health Act, 1875.

The power of local authorities to enforce drainage of undrained houses is contained in Section 23 of the Public Health Act, 1875.

HOUSES TO BE DRAINED INTO NEW SEWERS

Public Health Act, 1875, Section 24, states : Where any house within the district of a Local Authority has a drain communicating with any sewer, which drain, though sufficient for the effectual draining of the house, is not adapted to the general sewerage system of the district or is in the opinion of the Local Authority otherwise objectionable, the Local Authority may on condition of providing a drain or drains as effectual for the drainage of the house, and communicating with such other sewer as they think fit, close such first-mentioned drain and may do any works necessary for that purpose, and the expenses of those works and of the construction of any drain or drains provided by them under this section shall be deemed to be expenses properly incurred by them in the execution of this Act.

Section 18, Public Health Acts Amendment Act, 1890, deals with steps to be taken in connecting a house drain to a public sewer.

Section 41, Public Health Act, 1875, deals with combined drainage.

The Rural model by-laws in relation to drainage are practically the same as Urban by-laws; the by-laws naturally vary in different districts to suit the requirements of the district.

All Local Authorities have their own by-laws which are based in principle on the model by-laws of the Public Health Act, 1875. When construction of drains is about to take place the by-laws of the district should be obtained and studied, so as to obtain a knowledge of the requirements in that particular district.

The basis of the provincial sanitary law in England and Wales is the Public Health Act, 1875.

The sanitary laws in Scotland are based on the Burgh Police (Scotland) Act, 1892, and the Public Health (Scotland) Act, 1897.

The sanitary laws in Ireland are based on the Public Health (Ireland) Act, 1878.

CHAPTER IV

RETAINING WALLS

Parts of Retaining Wall—Tumbling-in Courses—The Reducing Plumb Rule—Tumbling-in for Buttresses—Ratios of Width to Height.

RETAINING, or battering, or revetment walls are constructed in different ways, bricks being used as well as stone and concrete. They are intended to retain, or hold up, masses of earth or water. Their design, including dimensions, foundations, and angle of repose, is generally the concern of constructional engineers, involving consideration of maximum horizontal thrusts, place of rupture, stability, etc.

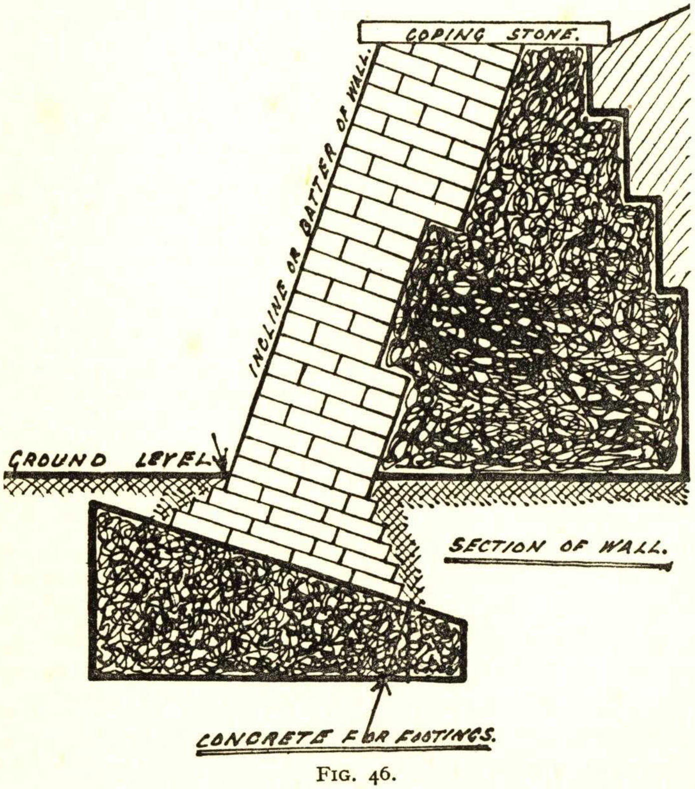


FIG. 46.

Parts of Retaining Wall.—In Fig. 46 we have an illustration of a retaining wall, designed for the purpose of resisting thrusts which are brought to bear upon it by the volume or mass of earth behind it. This shows the base concrete, footings, and section of the wall with the external face built at an incline. The width of brickwork is 18 inches, which is blocked at the back face of the brickwork. Behind this is formed a section of concrete, which is finished with various steppings on the internal face. The blocking in the back internal face of the brickwork forms a good key for the concrete. Behind this concrete is the earth embankment, which this compound retaining wall has to resist. The top of the retaining wall is finished with a 3-inch York coping stone for the purpose of weathering the brickwork and top portion of the concrete.

I do not propose to go into the various methods of finding the maximum horizontal thrust or the plane of rupture, or to calculate the stability of the wall; my chief aim is to explain to the bricklayer the purpose for which the retaining wall is built and the practical method used in constructing such a wall. This method of retaining wall is seen very often on the various railways, causeways, or highways, in which they are used to resist the various thrusts from embankments, etc. Walls of this class are usually built with hard burnt stocks, or blue Staffordshire bricks, bedded in a good cement mortar.

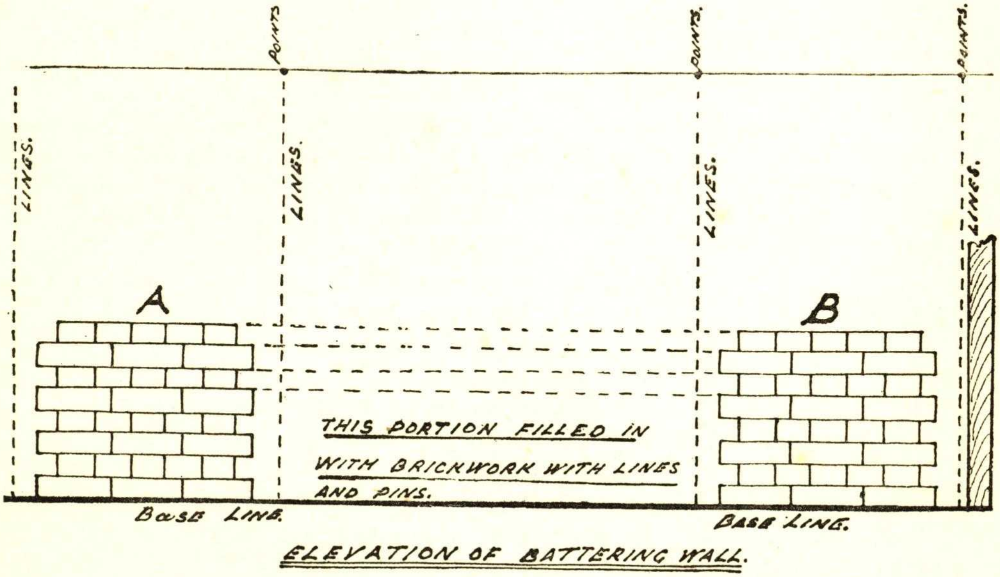

POINTS.
POINTS.
POINTS.
LINES.
LINES.
LINES.
LINES.
A
B
THIS PORTION FILLED IN WITH BRICKWORK WITH LINES AND PINS.
BASE LINE.
BASE LINE.
ELEVATION OF BATTERING WALL.

FIG. 47.

Fig. 47 gives the elevation of a retaining wall in the course of construction, showing the practical method which is used. The thick bottom horizontal line is the base line of the retaining wall, or the level of the brickwork at ground level. This point is marked by Fig. 46 in the section with an arrow at the base of the wall. This determines the bottom point of the inclined surface of the wall. The next step is to determine the top point of the incline of the wall. In the illustration (Fig. 47) these points are marked along the horizontal top line and marked points. A horizontal profile is generally fixed at these points to enable spikes to be driven in at these spots. From these top horizontal points to the bottom horizontal points a line is stretched, which line gives the bricklayer the inclined face surface of his brickwork. If the wall is of a considerable length, the wall will have to be built in several sections, Should the wall not incline very much, a reducing plumb rule can be used for constructing the two small sections of brickwork at A and B, which gives the batter of the reducing plumb rule to correspond with the same incline as that of the stretched lines, extending from the bottom to the top horizontal points. The two portions of brickwork at A and B act as corners in the ordinary way. From these the bricklayer can stretch his horizontal line from one to the other, and in this way can fill in the centre portion of brickwork course by course at the same inclined face as the two corners, until he has filled the middle portion to the same horizontal level as the two corners at A and B. This can be repeated until the whole height of the wall is attained. Another method used consists of fixing profiles which can be placed at each end, as shown on the right, the surface of the profile to correspond exactly with the inclined surface of the wall. The stretched line from the bottom to top points will give this position. When this is securely fixed the course can be marked upon it in pencil, or better still, fine saw-cuts, which cannot be obliterated like the pencil line. These profiles can be fixed at each end of the section of brickwork required to be constructed and the line stretched horizontally from one to the other. By this means the bricklayer can proceed with the construction of the wall between them. After the section has been completed, the profiles can be taken down and another section commenced. The horizontal dotted lines show the positions of the line stretched from the A to B portion of brickwork. The profile is shown at the right hand side of elevation, which can be extended to the top horizontal points.

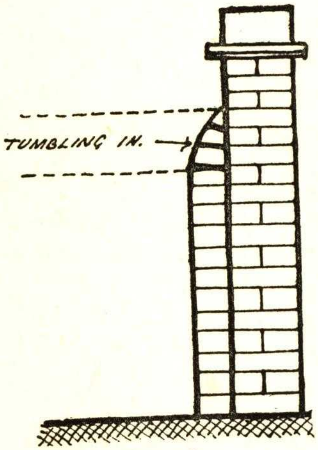


FIG. 48.

Tumbling-in Courses.—Fig. 48 is an illustration of a section of a 9-inch wall with a pier projecting from the face of the wall 4½ inches. The top portion of the projecting pier shows the method of reducing the brickwork from the face of the pier to the face of the 9-inch wall. This method of reducing these three top courses of the pier to the face of the 9-inch wall is known as tumbling-in courses.

The Reducing Plumb Rule.—Fig. 49 gives the section of a battering wall, with the reducing plumb rule placed in position against the inclined surface of the wall. The wall is marked by horizontal dotted lines, showing 12-inch divisions. The perpendicular dotted line which is shown on the external face of the wall, starting from a point at the base, against the face of the wall, and terminating at a point 10 feet in height and 6 inches from the face of the wall, shows exactly the incline of the external face of the wall, which is 6 inches in 10 feet, or 3 inches in 5 feet. The reducing plumb rule is made to a convenient size, so that the bricklayer can handle it with ease. It should be observed that it is made 3 inches wider at the top than at the bottom. The external perpendicular edge is parallel with the vertical line on the rule, against which the lead bob line swings. The internal perpendicular edge is made in an inclined position, corresponding exactly to the amount of inclination which is to be defined for the face of the wall, that is, 3 inches in 5 feet, or 12 inches in 20 feet.

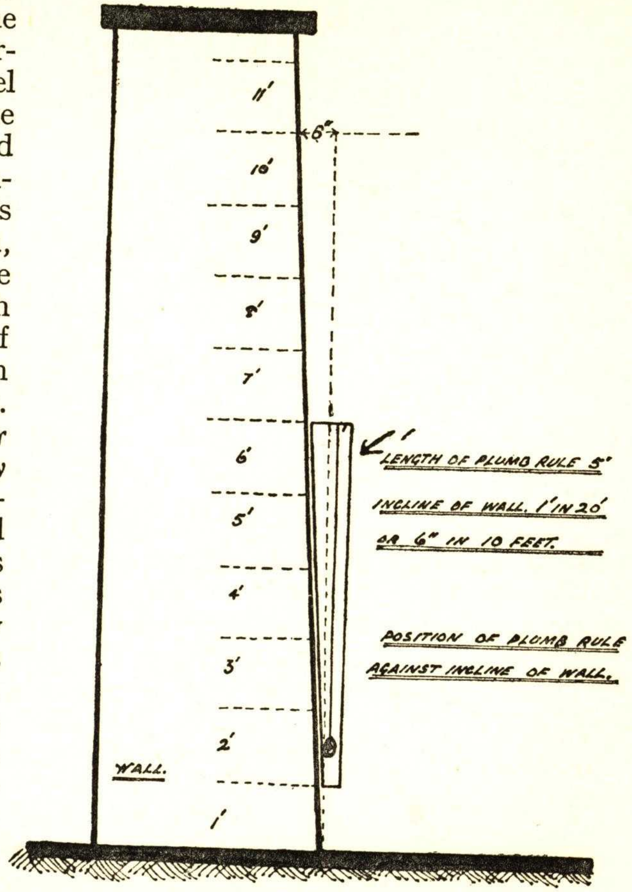


Fig. 49.

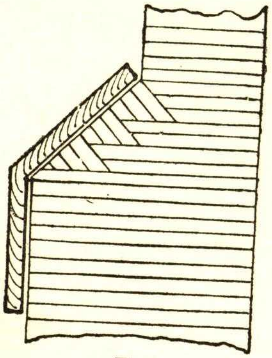


Fig. 50.

Tumbling-in for Buttresses and Chimney Stacks.—Fig. 50 is an illustration of the method used in tumbling-in for buttresses or chimney stacks. This method is used in chimney stacks when the width is required to be reduced. The inclined surfaces as used in buttresses reduce the thickness of the buttress from one face surface to the other. The method adopted in the construction of these inclined surfaces is to fix the external faces of the bricks to a template (or "gun," as it is termed in the trade). The gun is seen in the illustration (outside the wall), placed in position against the inclined surface, the face of the bricks fitting against the internal edge of it. The gun is held in position as every inclined course of bricks is laid. The ordinary square can be used with the gun by placing the stock of the square on the external edge of the gun, with the blade running at right angles to it. This ensures every inclined course being laid square with the face of the external inclined surface of the tumbling-in brickwork, the blade of the square fitting the top surface of the inclined brick each time they are placed in position. The gun usually consists of two pieces of batten screwed together in the right inclined position, one resting against the perpendicular face of the wall and the other resting against the inclined face of the wall. This method shows the inclined bricks cut and splayed, resting on the horizontal beds every third course.

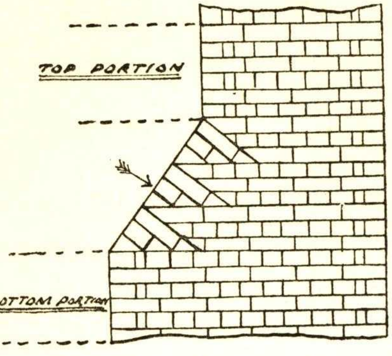


Fig. 51.

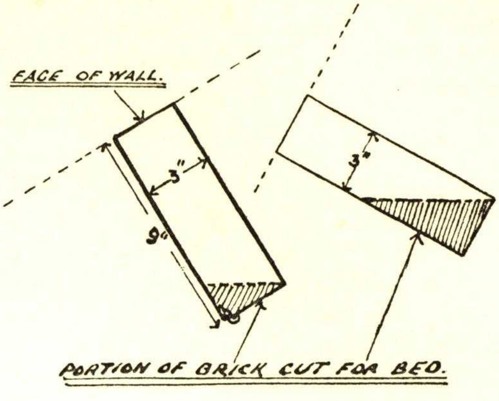


Fig. 52.

Fig. 53 shows the method of cutting the bricks at the ends of the inclined courses, where they meet the horizontal courses. Fig. 52 gives details of cutting.

Toothing.—Fig. 51 shows another method used, in which the internal ends of the inclined courses are finished by toothing, the whole being built in English bond.

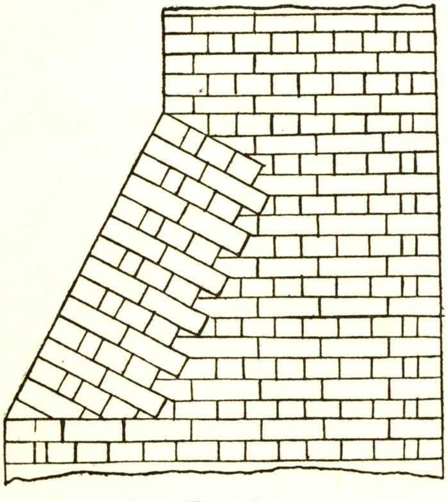


Fig. 53.

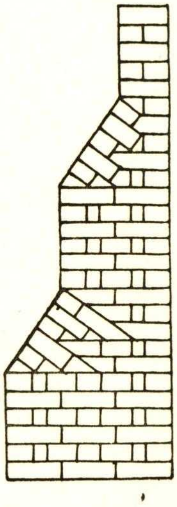


Fig. 54.

In an alternative method to that seen in Fig. 51, built in English bond, every first, second, and third inclined course finishes internally horizontally with the courses of the other brickwork. The thickness of the bottom and top portions of brickwork is seen between the horizontal lines, the bottom portion being six bricks in width, and the top reduced portion being four bricks in width. The width of reduction, formed by the tumbling-in courses, is two bricks in width, that is, taking the width horizontally.

Buttresses.—Fig. 54 gives the section of a buttress which is built against and bonded into a 9-inch wall, which has also two inclined surfaces, the width of the brickwork being reduced. The same method is used in the construction as explained in the other illustrations. The lowest tumbling-in portion consists of the internal ends of the inclined courses finishing horizontally with the top surface of the internal courses. In the top portion of the tumbling-in courses, the internal ends are toothed into the wall.

Fig. 55 shows the elevation of the buttress, and the elevation of the 9-inch wall at either side. The two perpendicular lines, which extend from bottom to top, are the external corner lines of the buttress. The bond on the face of the buttress is shown, also the header at each side, which shows as a closer on the face, the remaining 2¼ inches being hidden behind the face stretcher of the buttress.

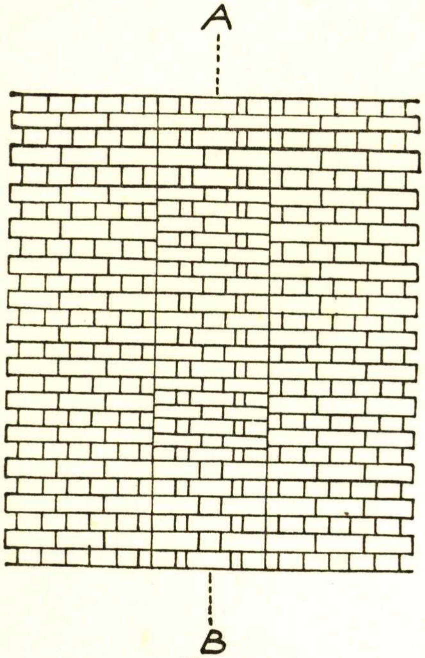


FIG. 55.

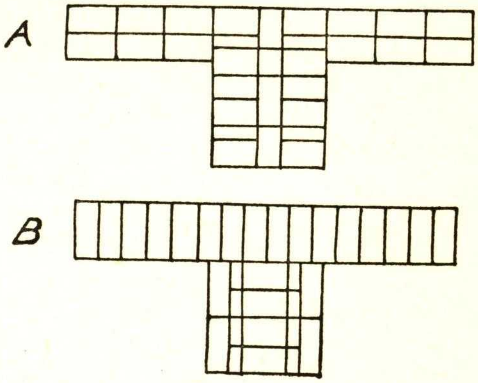


FIG. 56

Fig. 56 shows the plans of two courses of the brickwork at the base of the buttress and 9-inch wall, A showing the plan of the stretching course in the 9-inch wall, with the buttress set out, and B the heading course in the 9-inch wall, and the bond in the plan of the other course of the buttress.

Ratios of Thickness to Height.—In building and constructing boundary walls the safe proportions as to their thickness and height are to be considered; the following table gives the height and thickness with which these walls can be built in safety:

A wall	9	inches in thickness can be built to a height of	6	feet	4½	inches.
" "	14	" " " " " " " "	9	"	7½	"
" "	18	" " " " " " " "	13	"	0	"
" "	23	" " " " " , " "	16	"	6	"
" "	27	" " " " " " " "	20	"	0	"

CHAPTER V

REINFORCED BRICKWORK

Hoop Iron Reinforcement—Expanded Metal Strip—Steel Wire Mesh—Grip Steel Reinforcement—Strength of Reinforced Brickwork—Mortar.

THERE are several ways by means of which brickwork can be reinforced in order to give it added strength to withstand various strains—for instance, to prevent settlement where foundations are based on unstable soil (loose, marshy, or heavy clay), to strengthen openings, flat or arched, and also to withstand lateral pressure. The reinforcement is much the same as for concrete work, but lighter and not so complicated, though it requires equal care in laying, joining up, and protection.

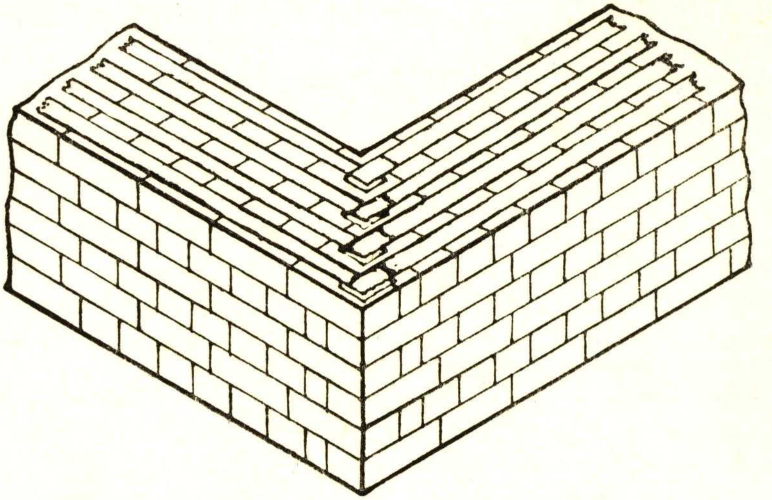


FIG. 57.

Hoop Iron Binding.—Hoop iron binding, or reinforcement by means of hoop iron, is the most elementary form of this work, but quite effective, particularly in preventing settlement and withstanding crushing strains, because it gives a good longitudinal tie. The method of applying this kind of reinforcement is shown in Fig. 57, which shows four strips of hoop iron running lengthwise from the corner in each direction. On the corner where the hoop iron meets at right angles it is tied together, the end of each piece being bent completely double for a length of 3 inches. One bent end fits into the other bent end at right angles, making a secure joint. It is then tapped lightly together. The illustration is of a wall which is 18 inches in width. The hoop iron is usually about $\frac{1}{16}$ inch in thickness and 1 inch in width.

This method is also very useful in walls which are subject to severe vibration, such as those in buildings which are erected near large railways, or buildings in main thoroughfares where there is a continual stream of heavy vehicles passing. It is also very useful in walls or houses which are built on the side of hills where there is sometimes a danger of landslides.

The brickwork on which the hoop iron is laid should be horizontally level and the hoop iron should have a coating of solution to prevent it rusting. For this purpose hoop iron is sometimes tarred and sanded; the sand also gives it a better key or adhesive power when bedded in the brickwork. At other times it is galvanised or it may be given a wash of Portland cement (in liquid form). Hoop iron is also used on walls which have been toothed, when a short length is extended beyond the toothing to tie into the fresh brickwork, when it is built afterwards against the toothing. This strengthens the point where the two walls meet at the toothing point.

When bedding the hoop iron on walls great care should be taken to see that it is bedded solid and that no air holes are left after this operation. There should be no bends or kinks in the hoop iron. It should be laid in a straight, flat line as far as possible so as to enable it to bear the full longitudinal strain. If there were one or two places where the hoop iron was slack or bent it would probably be at these points where the wall would settle or crack if a settlement did take place. These cracks are, of course, the result of an irregular settlement of the walls due to their resting on soil having an unequal bearing power. It is largely in order to resist this that reinforcement is adopted.

Expanded Metal Strip.—A special type of the well-known expanded metal, known as "Exmet," is extensively used in this kind of work. This class of reinforcement consists of metal sheets which are mechanically stamped with cutting dies in such a way that slits are made in trellis form, the thin ties or slit pieces projecting in loops on the sheets being released from the press. So the mesh forms a continuous sheet or strip and on being embedded in mortar provides an excellent key as the mortar is pressed between the slits, thus holding it firmly in position and consolidating it with the brickwork. "Exmet" is lighter, with a more open mesh, than ordinary expanded metal, is made in 20, 22, and 24 gauge mild steel, with meshes of 2½ inches, 7 inches, and 12 inches wide, in flat lengths up to 16 feet or coils of 75 feet and 270 feet. It is treated with a mineral oil process and subsequently dipped in asphaltum. This coated steel mesh is easily cut, is sufficiently ductile to enable it to be bent or doubled over, and remains flat when opened out, showing no tendency to curl up.

Fig. 58 gives a view of a hollow or cavity brick wall reinforced with "Exmet" bedded at each 4½-inch thickness of the wall. It is usually laid on every fourth or sixth course. The external edges should be 1 inch from the external and internal faces of the wall and thoroughly well protected with lime or cement mortar. Although protected by the oil and asphaltum baths, it is not advisable to use mortars containing slag or other acid-producing ingredients. Strips should overlap at least 3 inches in longitudinal lengths, but the ends may be bent up or down and tailed into the brickwork. This is a particularly good plan in all bridging or arching work. In wide walls two strips of 2½-inch mesh can be used, with a slipet longitudinal lap, but it is better to use the 7-inch or 12-inch strip as occasion dictates.

Fig. 59 shows the angle of a 9-inch wall which is reinforced with the same material, but of greater width.

In cavity walls of unequal thickness, reinforcement of the narrower wall tends to equalise stability, with resistance to crushing and thrusting strains.

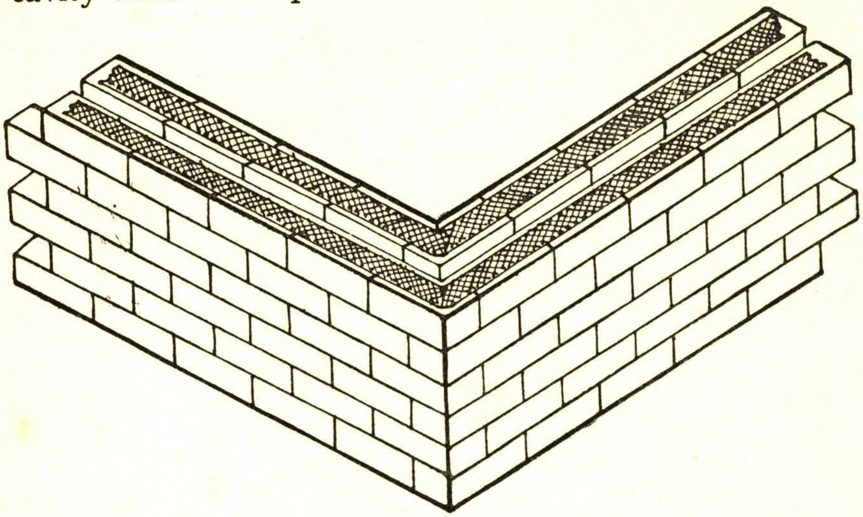


FIG. 58.

In walls of 9 inches or more in thickness the reinforcement may be staggered. That is to say, in one bed joint the strip is laid 1 inch from the outer face and the next layer 1 inch from the inner face, and so on alternately. This economises reinforcement and is quite effective.

Steel Wire Mesh.—Another type of reinforcement for brickwork is a woven wire mesh. It is applied in the same way as above described, but instead of overlapping joints it is usually butted and wired together by loops.

Vertical Reinforcement.—Both "Exmet" and wire woven reinforcement are occasionally used vertically—for instance, when refacing or veneering is resorted to. When laid on edge the strips should be set in the longitudinal vertical joints, midway between two adjoining bed joints.

Grip Steel Reinforcement.—Grip steel reinforcement is another patented system used for partitions and walls. It is a system of building with special grooved bricks, set on edge and reinforced through the grooves by steel wires. Bricks are supplied in two sizes, 9 inches by 4½ inches, and 9 inches by 6 inches, 2 inches thick ordinary walls, but can be obtained in thicknesses up to 4½ inches. The grooves are on both sides of the bricks and the wires are embedded in these. It is a system that adds strength for resistance to lateral thrust and prevents bulging of the partitions having to bear same weight.

Strength of Reinforced Brickwork.—Tests prove that reinforcement adds greatly to the strength and stability of brickwork. A hollow brick wall supported on two piers 10 feet apart with one end oversailing to an extent of 5 feet, in the form of a cantilever, wire mesh being used throughout, but no arching or tying being resorted to, the outer skin being 4½ inches and the inner 3 inches, was subjected for three days to a loading reaching 15,300 lb. on the centre portion and 3,500 lb. on the cantilever without sign of fracture or deflection. For lateral thrust, a panel of brickwork 3 feet by 2 feet and 4½ inches wide, reinforced at every joint, when ten days old was laid on its side supported at each and loaded, and failed at about 4,144 lb. or 758 lb. per square foot.

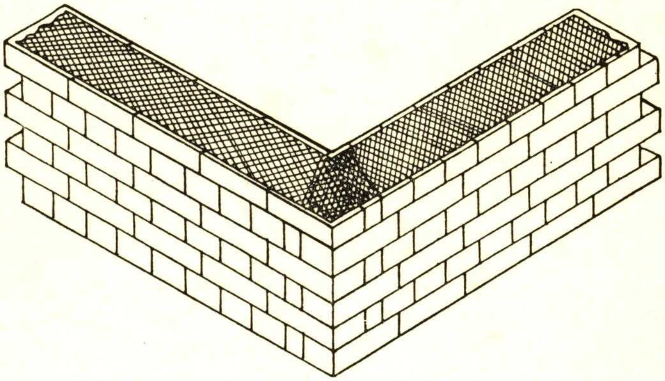


Fig. 59.

Mortar for Reinforced Brickwork.—As already stated, crushed slag should not be used in making mortar for this class of work. Three parts of a clean, sharp, hard sand (washed if necessary to remove earth and dirt), to one part of Portland cement, gauged rather stiff, gives the best result. Great care should be taken that the water is clean. Saline water should not be used.

CHAPTER VI

ARCHES

Purpose of the Arch—Skewbacks—Construction of the Arch—Rough Arches—Semicircular Arch—Inverted Arch—Dutch or French Arch—Trimmer Arch—Relieving or Camber Arch—Gauged Arches—Cutting the Bricks—Building the Arch—Ranyard—Arches—Wave Arches—Purpose-made Bricks.

An arch is a construction of brick, stone, or other material, arranged in the line of a curve, except in the case of concrete, being built up of units of a wedge-shape, which by mutual pressure, support each other. Or in other words, the thrust which is brought to bear upon the arch is transmitted from one unit to another, each one taking its share, and by so doing, equally distributing the thrust throughout the whole of the arch.

Purpose of the Arch.—Arches are constructed to bridge the span of various openings, such as window and door openings, and to carry the weight of brickwork above these openings. The original position of the arch is maintained by being able to oppose the thrust which is brought to bear upon it by the weight of brickwork. This thrust comes almost entirely from above, and as this weight bears upon it it is equally divided to all the units of the arch, thus causing an outward pressure at each side of the arch.

Skewbacks.—In order to oppose this outward pressure, and to maintain the original position of the arch, sufficient support must be obtained at the ends of the arch to resist this pressure; therefore brickwork is constructed at each end in the form of a skewback or abutment, on which the arch rests. The skewback must be built strong enough to resist this outward pressure of the arch.

Construction of Arches.—The arch should also be of sufficient depth on the face to support the weight of brickwork above it. Piers upon which arches are built should be built strong and have sufficient area to resist the weight above them, such as in the case of the semi-circular arches. All the bed joints in arch work should be normal to the curve of the arch.

Arches are usually divided into two classes, viz., Rough arches and Gauged arches.

Rough Arches.—Rough arches are usually those which are constructed of ordinary bricks, or bricks which are not cut to a given shape or size. Arches such as the Relieving arch, the Trimmer arch, Inverted arch, French or Dutch arch, etc., all come under the heading of Rough arches. Rough arches, as stated, are usually constructed with the ordinary uncut bricks, and are therefore cheaper than the axed or gauged arches. If cutting is performed it is usually done with the trowel or bolster and hammer and formed roughly into shape. The joints of the rough arches are wedge shaped, and are generally built in half brick rings. This method is used to prevent a thick or wide joint at the top portion of the joint, between each brick. If the whole bricks were used in the construction of the rough arch, it would necessitate a very wide joint being made from the centre to the top of the brick, between each one. The half brick ring therefore reduces the thickness of the V-shaped joint. This thickness at the top of the joints is seen more especially in the rough semi-circular arch, in which the soffits of the first ring of the arch are laid to a very sharp curve. In the rough segmental arch the thickness of the V-shaped joints is not so prominent, as the soffits of the bricks are laid to a much easier curvature, therefore the joints become of a more uniform thickness throughout their length, on the face of the arch.

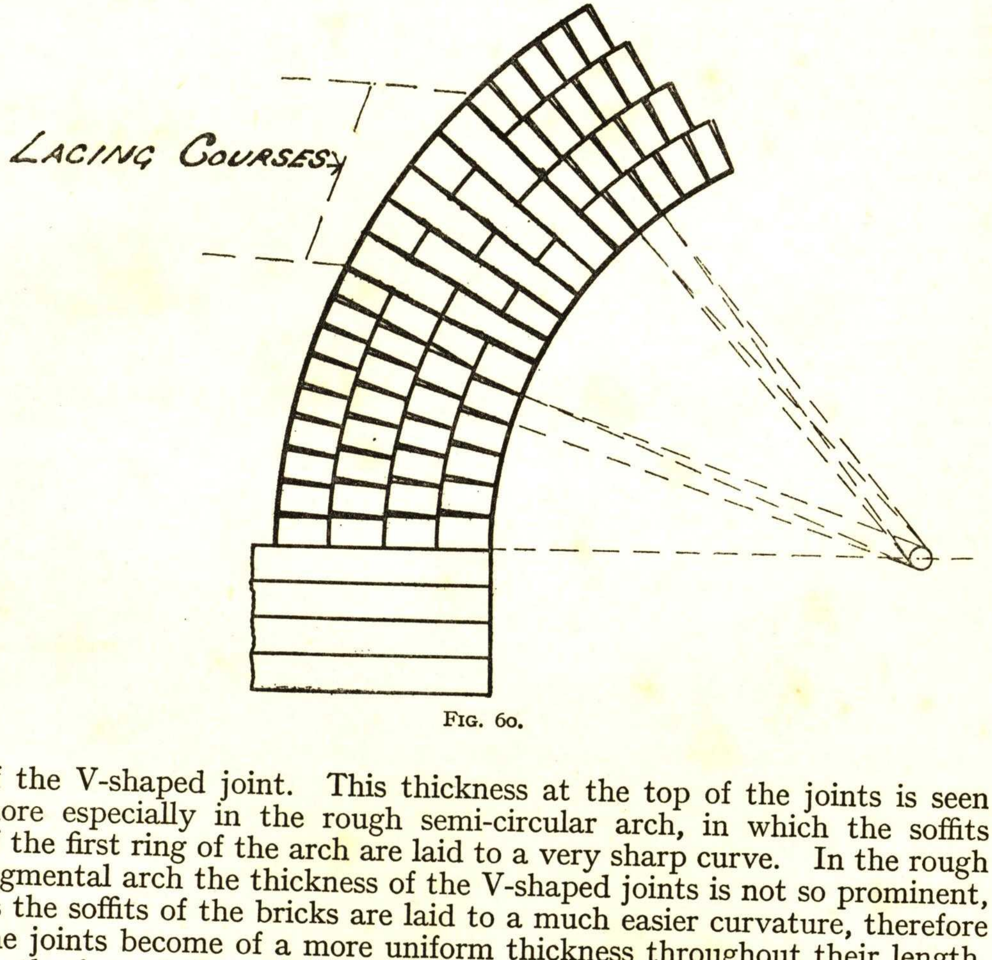


FIG. 60.

Semi-circular Arch.—Fig. 60 represents part of a rough semicircular arch formed with four half brick rings, showing the wedge shaped joints. As will be seen from this illustration a much larger joint would be required at the top if two whole brick rings showing stretchers on the face, were used instead of the four half brick rings. In an arch of this description, it is usual to insert at various points of the arch, several courses of whole bricks, to form a tie. These courses so formed in the construction of the arch rings, are known as lacing courses. They are also built in the arch with the object of distributing the pressure more equally over the sectional area of the arch. The bricks are usually cut to a rough wedge shape, so as to form uniform thickness of the joints throughout the length of the courses. Such arches are generally built in rough stocks or flattons, and sometimes the joints are roughly raked out, in preparation for cement work or plastering. At other times they are jointed with a flat joint as the work proceeds. This is often the case with the internal arches of factories, etc., where the face work of the brickwork is of secondary importance.

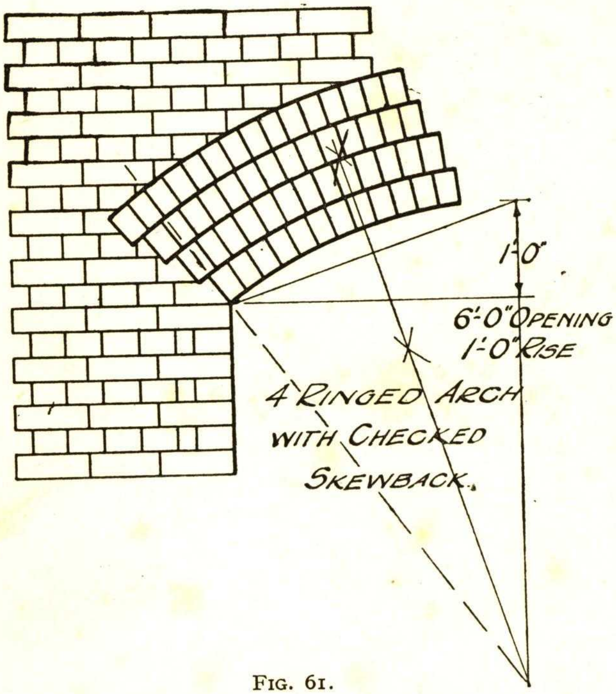


Fig. 61.

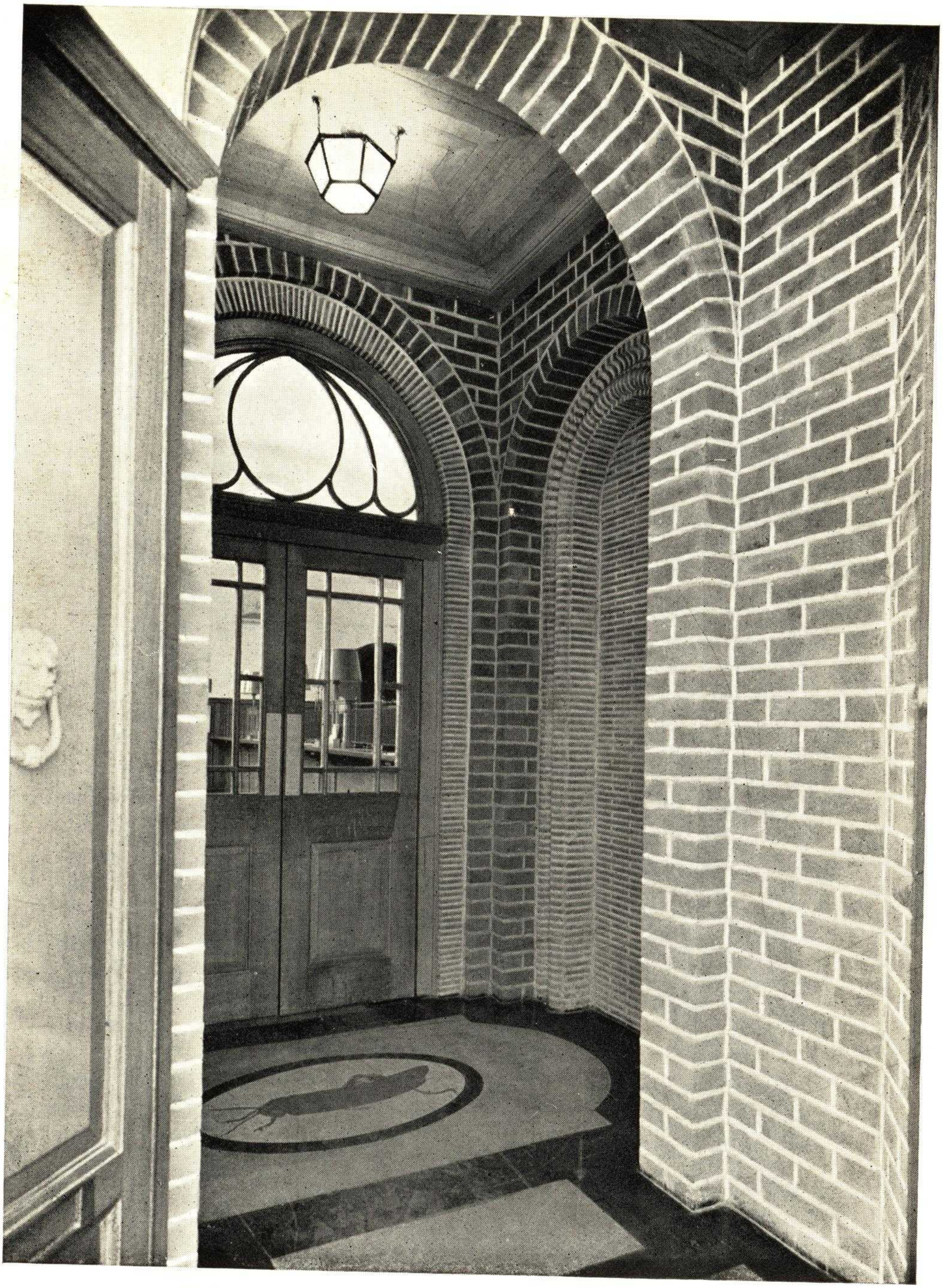
This form of arch is occasionally used for external work, and finished with a weather joint. For the purpose of drawing the V-shaped joints are radiated from each side of the small circle, which is scribed round the striking point of the arch.

Another form of rough arch is shown in Fig. 61. This is constructed with four half brick rings. It is an arch formed with a checked skewback. The first half brick in each ring recedes back beyond the ordinary line of skewback, the ordinary line of skewback being shown by a dotted line, which radiates from the striking point of the arch. Arches of this description are used for internal and external work, and if constructed with care, and neatly pointed, present a good appearance.

The striking point of the arch is shown at base of the triangle—the rise of the arch is shown with arrow-heads on the vertical line.

Other rough arches, such as the segmental, which are constructed of ordinary bricks, for instance, stock bricks, building reds, and pressed bricks, can be made to present a very good appearance, if carefully constructed and finished neatly with suitable joints.

Inverted Arch.—Another form of rough arch is the inverted arch, which is shown in Fig. 62. This is shown as being constructed with three



VESTIBULE, MARTIN'S BANK, BEXLEY HEATH.
Deane & Braddell, Architects.

half brick rings, and springing from the two piers on either side. This is really in the form of an inverted segmental arch, and the striking out is the same as previously shown. The inverted arch distributes the pressure, which is brought to bear upon the piers or abutments equally and uniformly over the whole length of the foundation. If no inverted arch was built between the piers, the weight which is concentrated upon each of the piers would have a tendency to cause an unequal settlement, due to the unequal distributed stress, caused by the concentrated loads upon the piers. These arches should be constructed with good materials and workmanship. In actual practice it is usual to first build the lower portion of brickwork as marked between the two horizontal dotted lines, and then work the shaped portion (which forms the bed for the first ring), to a template or mould, as shown in the diagram, This mould is made for an inverted arch of two half brick rings. The bricks which form the bed for the first ring of the arch should then be laid and bedded; these are shown in dotted lines. The template should then be held in position on the face of the wall, and the bricks, shown in dotted lines, should be marked with a pencil to the bottom curve of the template, and then the bricks after being cut to the pencil lines, can be rebedded and finally fixed in position. The template can be placed on the cut surfaces of the bricks to see if the curve is

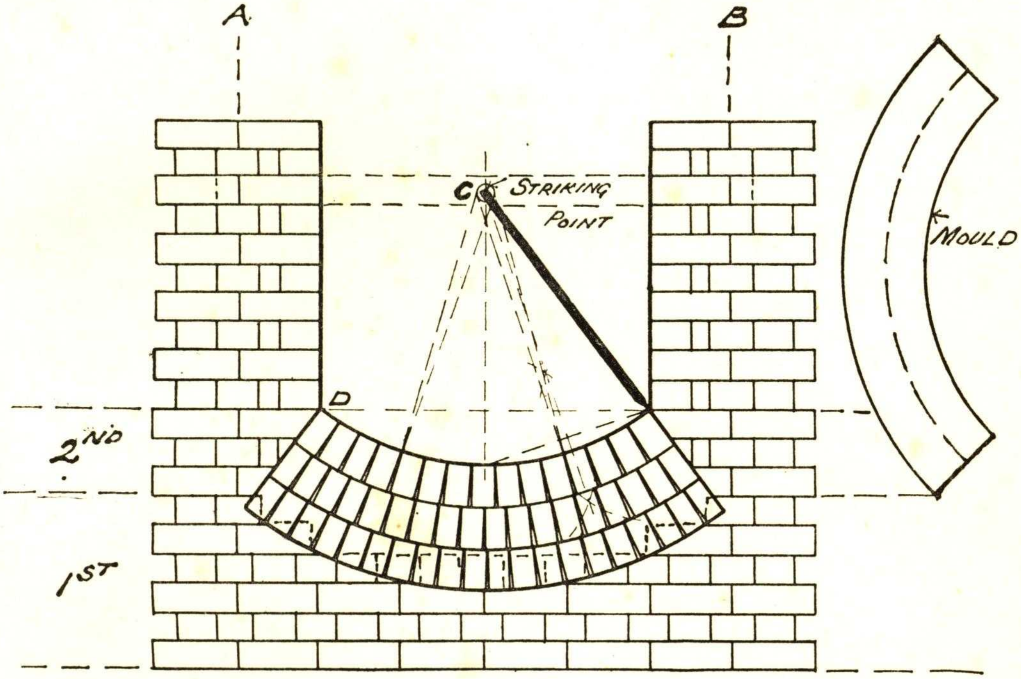


FIG. 62.

true. The first ring of the arch can then be bedded. The dotted line, which is shown on the template, can be used in the same way for obtaining the correct curve for the second ring by holding it against the face of the brickwork and marking the face of the bricks, in readiness for cutting. A larger mould would be required for the three half brick ring arch.

When all the three half brick rings have been constructed, the skewback can be formed by building up the second portion of brickwork as shown, and cutting the bricks to shape which are required to form that skewback. When this is completed the piers on each side of the arch can be built. The dotted lines which radiate from the sides of the circle round the striking point, show the method of forming the V-shaped joints.

Another practical method which is used for the construction of the rings of the inverted arch, is by the use of a trammel rod. The first portion of the brickwork is generally built, and toothed at each side in a vertical line in the piers with the points A and B. A piece of 4 inches by 3 inches deal is then placed in a horizontal position on to each side of the opening and bedded. This keeps it in a firm position. It should also be vertical with the face of the wall.

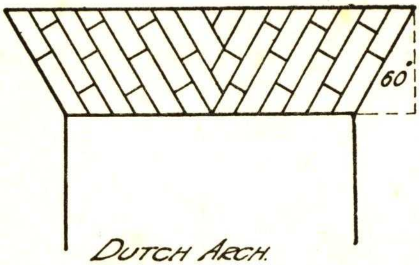


FIG. 63.

The striking point of the arch should be central with the opening and also central to the thickness of the 4 inches by 3 inches. A piece of batten should be nailed with a long French nail, into the striking point. This enables the rod to work freely. The rod should be long enough to reach the bottom curve on which the first ring of the arch is bedded. The rod can then be radiated backwards and forwards in order to cut the bricks required to form the bed for the first arch ring. These bricks can be marked by holding a lead pencil at the end of the rod and moving both to the curve. The second and third ring can be treated in a like manner, by shortening the rod to the required radius of each ring. The trammel rod as shown, shows the radiation length to the top ring of the arch.

After the arch is constructed the remaining portions of the piers on each side can be built up.

The longest radiating rod also gives the positions of the two skewbacks, by holding the rod so that it is in a position from striking point to springing point, that is, from C to D.

Dutch or French Arch.—Fig. 63 shows the Dutch arch or French arch as it is sometimes called ; this is a rough arch and also very weak. This form of arch is generally used for small openings where not much strength is required, or where the work is covered over, or finished with a cement or plastered surface. It is also very cheap and should not be used over an opening. If the soffit of the arch is more than 4½ inches from the face of the wall, the skewback is generally formed at an angle of 60 degrees, and all the beds of the bricks are formed to that angle. In some cases an iron bar is used as an extra support to carry the bricks. In this case the arch is constructed upon the iron bar, instead of being placed on a centre. When in construction the majority of the bricks are roughly cut to a splay to form the straight surface of the soffit and top portion of the arch.

Trimmer Arch.—Another form of rough arch is the trimmer arch; illustrations of this form of arch have been shown in the previous chapters on Fireplace Construction, etc. These arches are constructed in rough bricks, and are built to support the hearth in front of a chimney breast. Another form of rough segmental arch is usually constructed over fireplace openings, and formed of two half brick rings; sometimes whole bricks as stretchers on the face are used to form the arch, they are usually built upon the chimney bar.

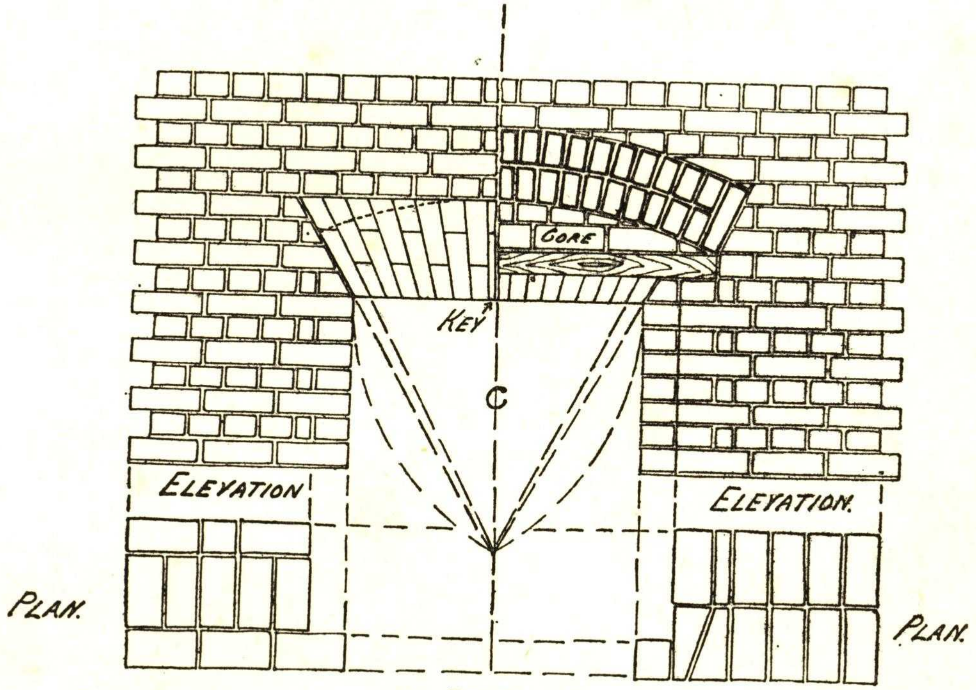
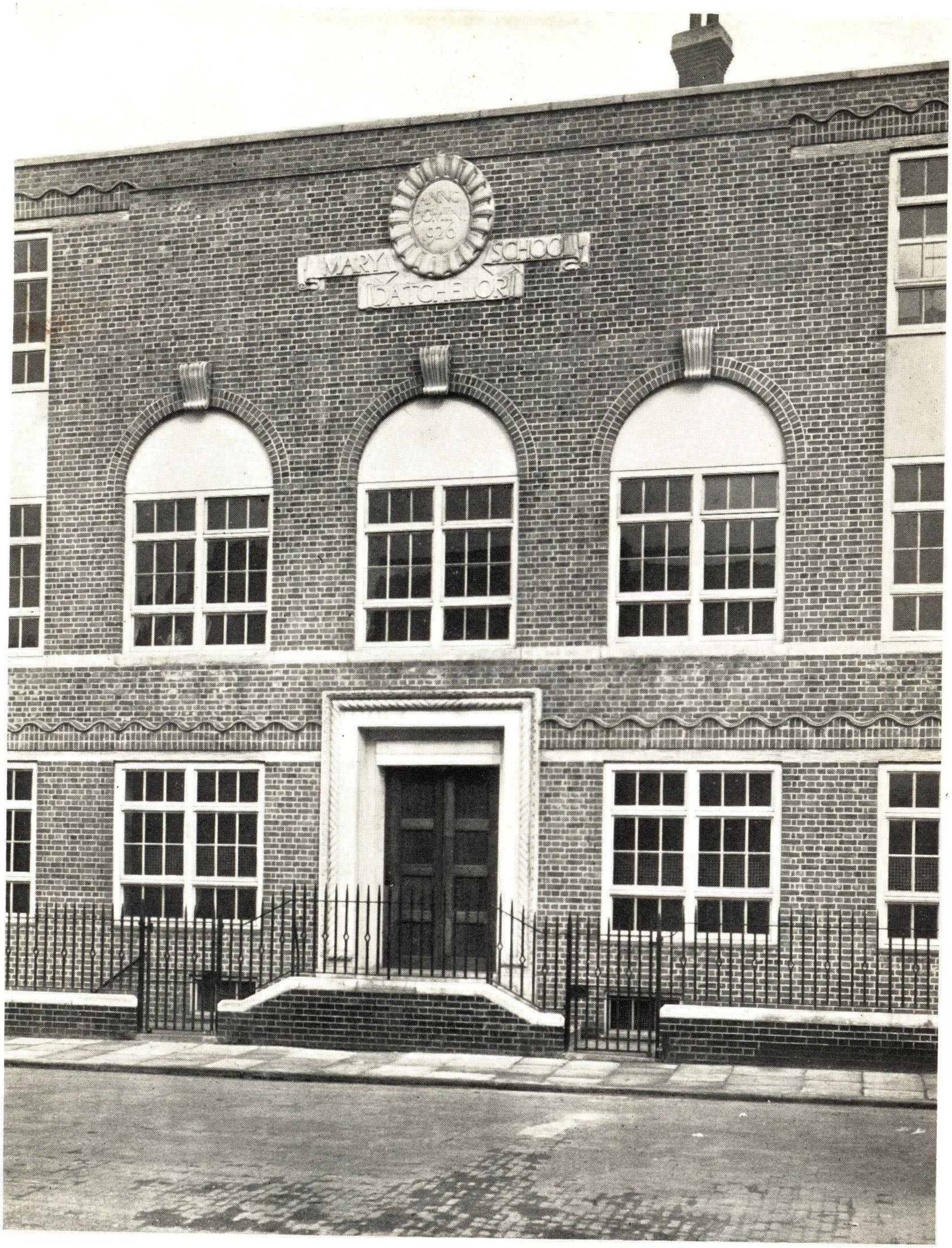


FIG. 64.

Relieving and Camber Arch.—Fig. 64 shows an illustration of another form of rough arch known as the relieving arch. This illustration also shows an elevation of a camber, or as it is sometimes called, the straight arch. This figure is drawn to show the position of the relieving arch on the internal face of the wall, and the camber on the external face of the wall in their relative positions. The relieving arch is sometimes built in divisions or rough walls and extends from one face to the other as in the case of a 9-inch wall ; or it may be constructed as in the present case as shown in illustration in an 18-inch wall. In this instance the gauged arch on the front face of the wall would be 4½ inches in thickness and the relieving arch forming the remaining thickness of the wall would be 14 inches in thickness. In the case of a wall of this thickness the relieving arch is generally built first. A lintel composed of two pieces of wood (one 9 inches by 3 inches, the other 4 inches by 3 inches), spiked together, is bedded in a level horizontal position on the inner 13½ inches of the wall This wooden lintel should extend at least 4½ inches beyond the internal jambs of the opening, as it forms a bed for the brick core. The core consists of two courses of brickwork, the top portion of which is roughly shaped to form the bed for the soffit of the relieving arch. The core is sometimes built to the shape of a mould or template specially made for the purpose. The core, and also the wooden lintel, is seen in half elevation. The bed of the lintel as seen is 3 inches above the soffit of the gauged camber. This margin allows for the bead of the door frame when placed in position. It will be seen that the back portion of the camber is shown extending 3 inches below the wooden lintel. The skewback is then formed and the half brick rings are placed in position on the brick core. Bricks with two deep frogs are very good for this purpose as they form a very strong key for the mortar joints when they are placed between the bricks. On the right-hand illustration the back of the front reveal is shown, which is recessed 4½ inches. The dotted line on the face of the camber arch, shows the position of the soffit of the relieving arch at the back of the arch.

Relieving arches should be constructed with good materials, and properly supported by a good lintel. They are very useful types and are used extensively to support loads across large openings. In the above illustration the wall is 18 inches in thickness, and the relieving arch takes up 14 inches of that width. The arch should be efficiently bonded in its width from the face to the back of the arch. It should also be of sufficient depth to carry the required weight above it. The half elevation on the left side of illustration showing the camber will be dealt with later on, in the chapters on Gauge Work. Two plans of the alternate course of the 18-inch wall are placed below these elevations, showing the opening, the reveals at each side of the opening and also the jambs over which the relieving arch is built. The plan shows the relative position of the arches over the opening. Outside 4½ inches is the position of the gauged camber, and inside 13½ inches is the position of the relieving arch. These positions are shown inside the parallel dotted lines on the plan.

Gauged Arches.—Gauged arches are those where the bricks which form them are cut to definite shapes and sizes.



PUPILS' ENTRANCE, MARY DATCHELOR SCHOOL, GROVE LANE, CAMBERWELL.
W. Curtis Green, A.R.A., and Partners, Architects.

There are two kinds of gauged arches. First, arches in which all the bricks used are cut with a wire cutting saw, and rubbed to their various shapes and sizes. Second, axed arches. The bricks which form these arches are usually too hard to be cut by the wire saw.

Cutting the Bricks.—These bricks are generally marked from a template, the shape of which represents the finished shape of the arch brick. The template consists of a piece of prepared wood ¼ inch to ½ inch in thickness. This template is placed upon the face side of the brick and marked by indenting the face of the brick at each side of the template with a small saw, which consists of a piece of tin about 6 inches by 2 inches, fixed into a piece of grooved wood to form a handle. This piece of wood is fixed horizontally along the top of the tin blade. The depth of the indent upon the face of the brick is usually about $\frac{1}{16}$ inch. Each end of the face of the brick is also marked in the same manner from the template. The rough shape of the brick is now obtained. The back of the brick is treated in a similar manner. The brick is now roughly shaped by removing the portions of the brick outside the template lines. These portions are removed with the aid of the hammer and bolster, the bolster being placed on the indented lines and struck sharply with the hammer, which removes these portions of brick on the front face and back. The two ends of the brick are marked in the same manner, by connecting the front and back template lines, and the portions of brick extending beyond the template lines are cut off the same way. When the bolster is used in removing the portions of brick beyond the template lines, the bolster when resting on the indented line should be inclined towards the operator, thus leaving the inner line of the indented line free and untouched. This gives a sharp arris to the line. Rough portions of brick are still left after the hammer and bolster have been used (the bolster only removing a part of the brick which is not required). The other portion is then removed by the scutch, which roughly finishes each surface. The brick is then finished off and the sharp arrises maintained by rubbing on a York stone (called the rubbing stone). The brick is then of the required shape. Before fixing the arch bricks, a joggle has to be made on each bed of the bricks. This consists of a channel about 1 inch wide, ½ inch deep, and 6 inches long, which extends from the top of the arch brick downwards. This channel is made with the scutch, and is used for the purpose of receiving a cement grout, which is poured into these holes, when the arch has been constructed, in order to make it a more consolidated mass and to strengthen it.

Building the Arch.—After the bricks have been shaped and the finishing touch given to them by rubbing them on a York stone, they are ready to form the construction of the arch. The bricks should be placed in a position ready for use and should be well wetted before use. The arch is usually formed on a centre, which keeps the arch bricks in their positions until the arch is keyed up and grouted in with liquid cement. The method usually adopted before bedding the bricks, is to mark out in pencil on the centre, the position of all the bricks in the arch. This serves as a guide when placing the bricks in their positions. A special material is generally used for bedding the bricks. It usually consists of good Portland cement with a small percentage of sand added to it to make the material more workable. This material is termed gauged mortar. All the joints should be of a uniform thickness, and are usually $\frac{3}{16}$ inch to $\frac{1}{4}$ inch thick.

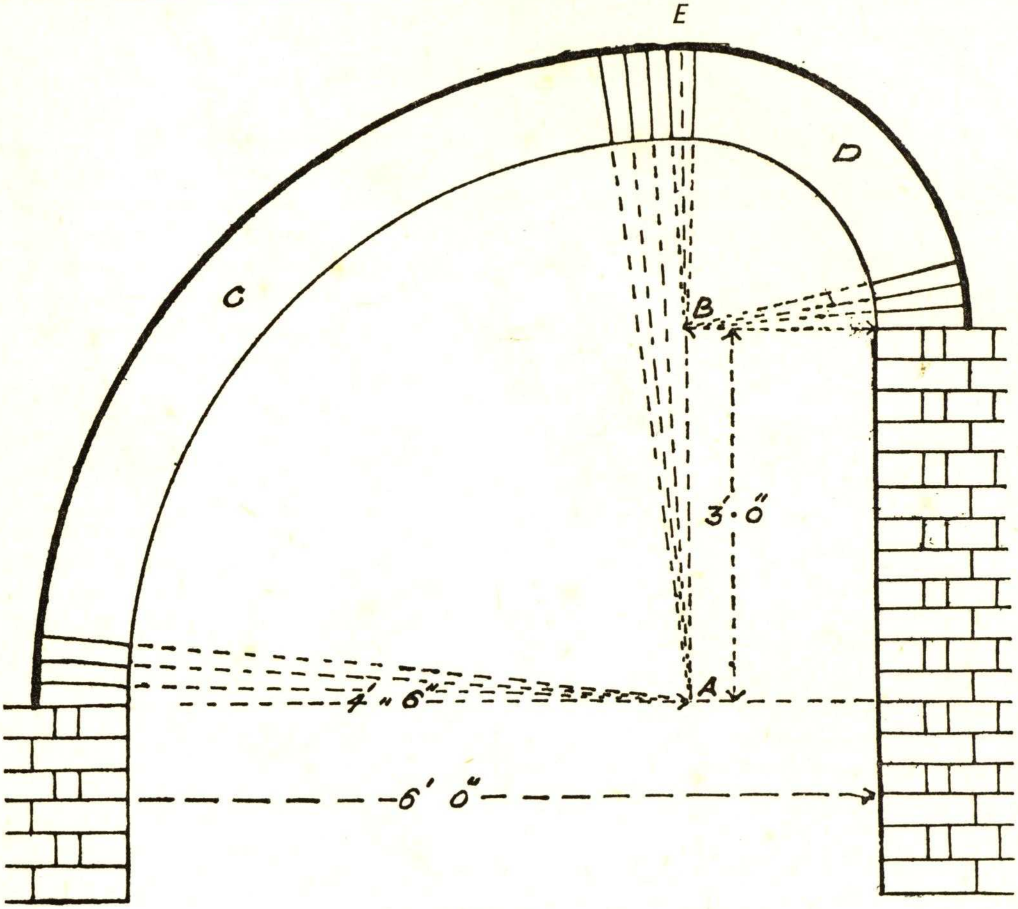


Fig. 65.

The first bricks to be placed in position should be the arch bricks that rest against each skewback, or springing base. Each brick should have an evenly spread bed of gauged mortar and should be pressed firmly against the preceding one, working the bricks on each side towards the centre brick, which is called the key. The key brick should have an even bed of material spread on both its beds and firmly pressed into its position. The arch should be straightened on the face with a straight-edge, a little longer in length than the opening which the arch spans. Each brick should be straightened in this manner as it is placed into position, so as not to disturb the joints between the bricks. If the arch bricks are all bedded in their positions and straightened afterwards on the face, there is a danger of breaking or disturbing the solid beds between the bricks.

These arches are sometimes put in position in the form of two half

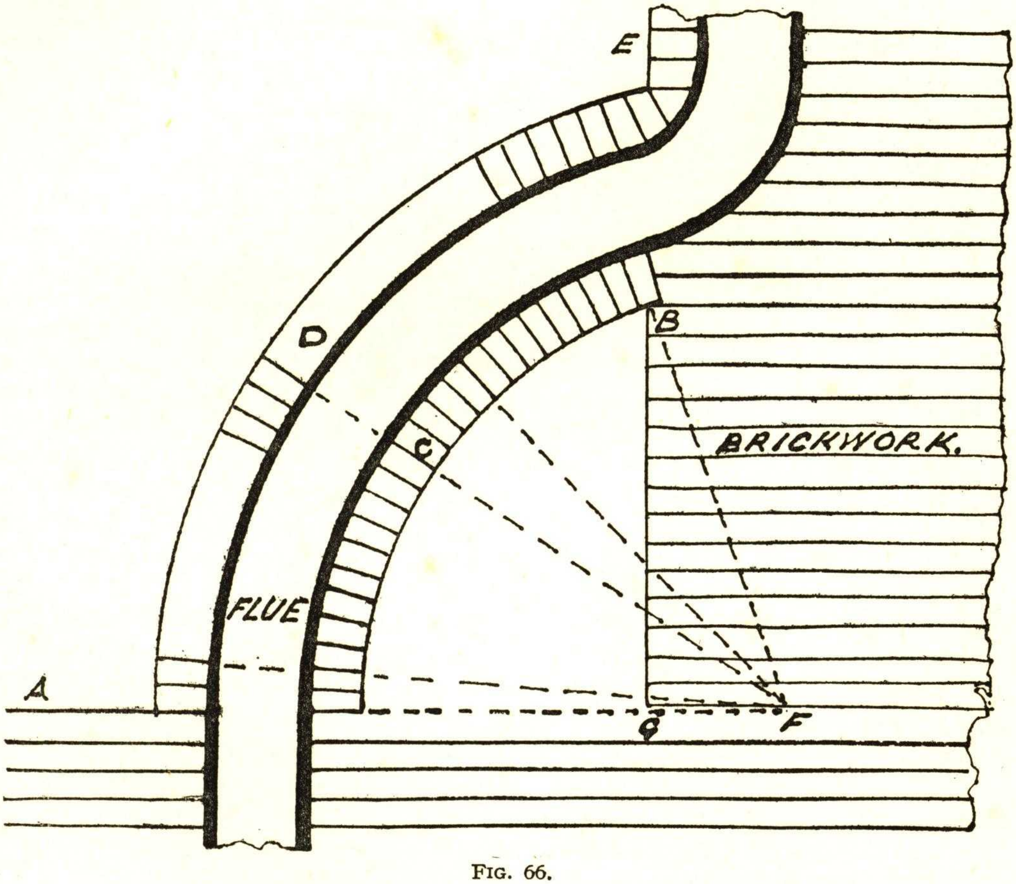


FIG. 66.

brick rings. After the arch has been finally straightened, and the key brick placed and bedded in position, the joggle holes are filled in with a neat cement grout, and the whole arch should not be disturbed until the material has had a reasonable time in which to set.

These arches are strong and have quite a good appearance when good bricks are used, and the work done neatly in a proper workmanlike manner.

Various Forms of Rampant Arches.—A rampant arch, as shown in Fig. 65, is formed of two compound curves. The larger of the two springs from the base line at the lower level and has a radius of 4 feet

6 inches. The curve at the higher level has a much smaller radius, which is 1 foot 6 inches, and the striking point is at B, the striking point for the lower level being at A. The key-brick for the double arch is at E. This form of rampant arch is used to span an opening when the brickwork at either side is of a different level.

In the illustration, Fig. 66, we have another form of rampant arch in which the brickwork is at two different levels. The lowest level of brickwork contains a 9-inch by 9-inch flue, and this is required to be brought into a position at a much higher level at B. In order to do this a rampant arch is formed, which consists of a 4½-inch casing of brickwork to the flue. It will be seen that in the bottom layer the end face of the bricks at C is built on a wooden centre. Two courses of these bricks are laid on their edge, which form a bottom layer for the flue 18 inches wide and 4½ inches in thickness. Upon this are built the sides of the flue, which consist of three courses of bricks laid in the ordinary way, with their faces in a vertical line with the faces of the brick on edge course below. This having been done, it forms the inside flue 9 inches by 9 inches. Before covering in the top of the flue, the internal side faces and the bottom should be pargeted and finished with a smooth surface. The top covering should then be constructed, from the lowest end. This is sometimes constructed by bedding slates in cement and sand, and then building up one or two courses of bricks on their edge above it. The slate forms a good smooth surface for the soffit of the flue. In the brick construction for the top covering, the brick on edge courses should be properly bonded together, and about 18 inches of work done at each time from the springing upwards. This enables the bricklayer to parge the soffit of the flue at regular intervals as the work is in progress upwards towards the higher level, at which the flue enters into the main wall. The face of the main wall shows in a vertical line from G to E. The lower level of brickwork is at A. The radius for the rampant form is attained from point F. The drawing of the flue shows a section of it, with the pargeting at the bottom and soffit.

There are other forms of rampant arches. For instance, those used in connection with the construction of staircases, etc., where it is required to span openings at different levels, or in the case of sharp inclined surfaces from lower to higher levels.

Wave Arch.—Fig. 67 shows the elevation of the wave arch, which is used and supported by a specially constructed frame cast for the purpose. The striking points for the intrados curve of the arch, which is illustrated at the left half of drawing, are at G, with a radius G to H. The top portion of the intrados curve is struck from point G. With a radius from G to J the top left-hand extrados curve is struck from joint G. This forms the top left-hand portion of the arch. The lower portion is struck from points E and D, E being the striking point for the extrados curve and D being the striking point for the intrados curve. The skewback of the arch is obtained from point F on the centre line of the arch. From this point it is continued to point A and a line drawn from A to L, which forms the skewback line. The lines on the arch, which form the joints between the voussoirs, are all radiated from point F on the centre line. The specially made frame, a portion of

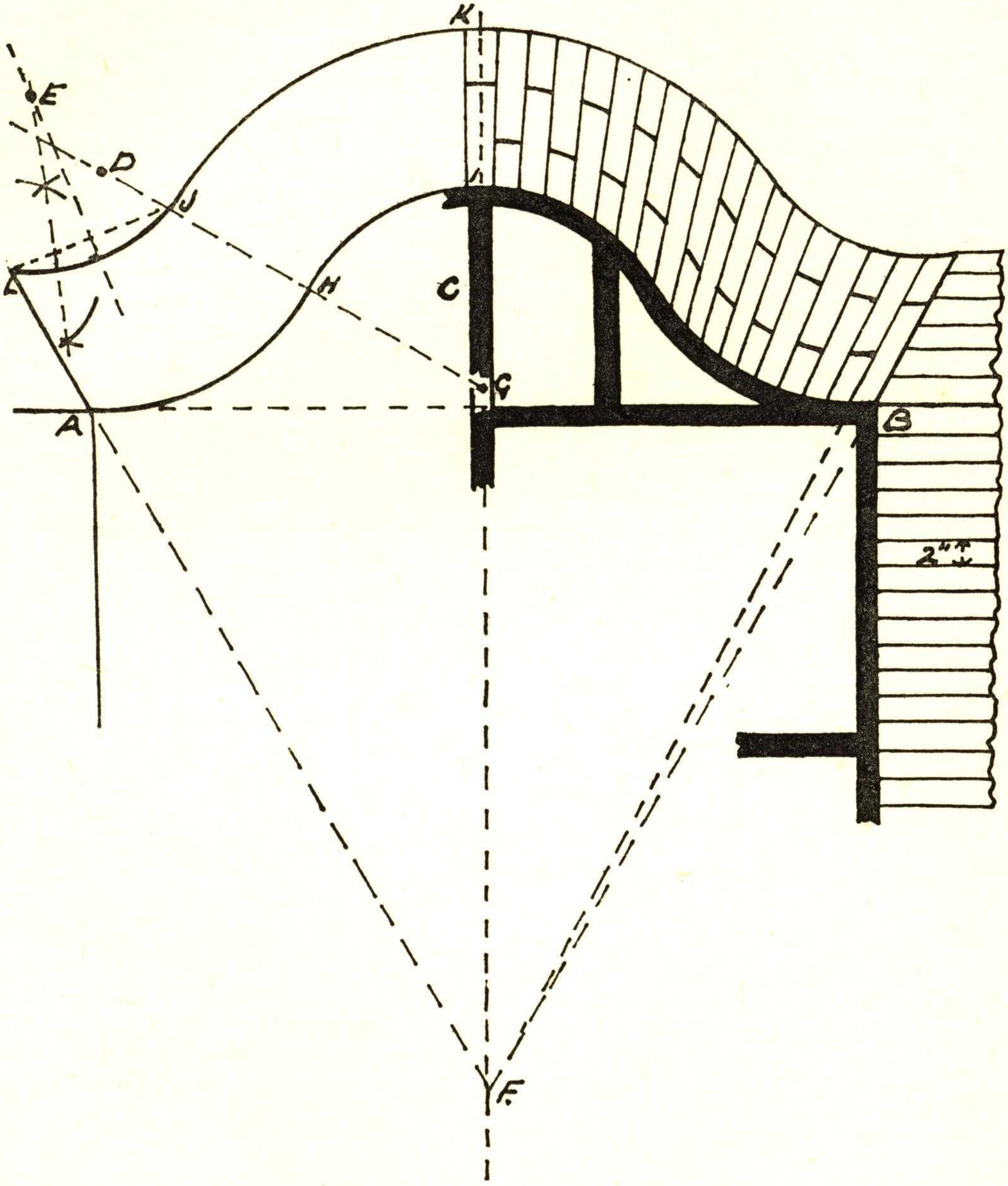


Fig. 67.

which is shown below the arch, supports it. Usually the face of the frame recedes back from the arch about 1 inch or 1½ inches.

Purpose Made Bricks.—Arches composed of purpose made bricks are constructed on a large scale in various parts of the country. Various kinds of bricks are used for this purpose such as pressed bricks, red bricks, etc.; if constructed of good material they are very strong and durable, but give a mechanical and not an artistic effect. Bricks of various sizes for different arches are now stocked by the makers, which are of a usual standard size.

Flat arches are sometimes constructed with glazed bricks which form the face work over small openings. These are constructed on a flat horizontal centre. The bricks used have two deep frogs. Each brick is well wetted and bedded with a thin cement joint about ⅛ inch in thickness. The frogs of the bricks are left hollow, and the top portion of each brick is scutched out to form an opening to the frogs. When the bricks have been straightened on the face, next cement grout is poured into these holes, which fills the two frogs at the sides of the joint completely, and thus forms a good solid keyed joint between each arch brick. Usually there is no skewback to this form of arch, just a perpendicular roughed face for the first brick to be bedded against.

CHAPTER VII

CORNICES

Designing Cornices—Cornice in Purpose-made and Moulded Bricks—Weathering and Damp-proof Courses—Finishing Touches—Cornice with sunken Panel—Cornice with moulded Projecting Courses—Enrichments.

A CORNICE is the projecting finish, or cresting, of a structure, commonly seen in the form of a moulding, or group of mouldings, crowning a wall, indoor or out, or the label over a doorway, window or other opening. Cornices vary greatly, for besides those appropriate for the several Orders of Architecture (the Tuscan, Doric, Ionic, Corinthian, and Composite) there are others peculiar to the Norman and the Gothic, and in addition fancy compositions.

Designing Cornices.—The designing of cornices, however, is almost invariably a matter for an architect. The general foreman, bricklayer foreman, and bricklayer, find their instructions for the construction of the cornice in the specifications, and by means of the detailed drawings. It is an important feature of architecture, much of the successful appearance of a building depending upon the proportions and enrichments of the cornice, so naturally the architect and builder lay stress on the careful carrying out of these parts of the structure, and as the bricklayer, more particularly in the enrichment of gauged work, has opportunities of showing his skill, even in some cases his artistic taste and fancy, it is well for him whenever possible to acquire some knowledge of the Orders. Here it will be merely necessary to describe a few examples for the guidance of the operative.

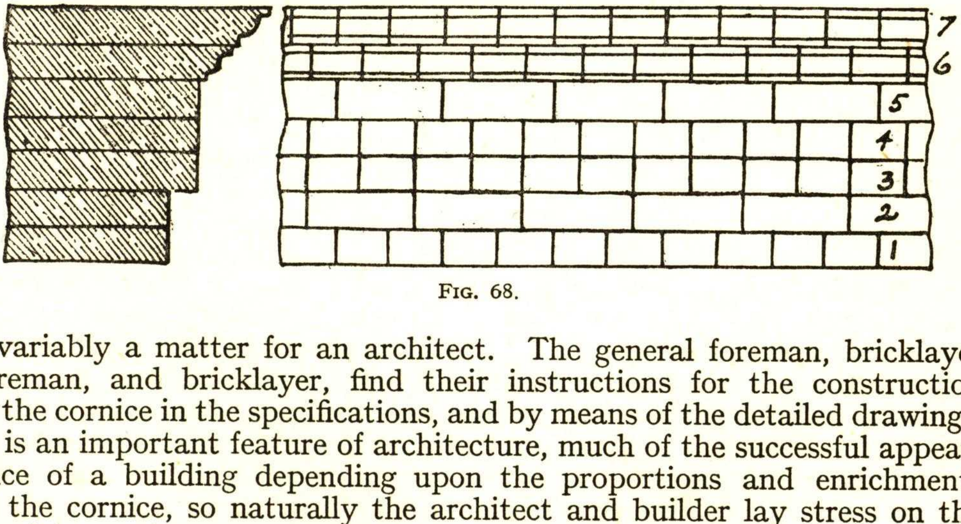


FIG. 68.

Cornice in Purpose-Made and Moulded Bricks.—A favourite type of cornice built in purpose-made and moulded bricks is shown in Fig. 68.

The bricks used in their construction are red builders. The courses marked 1 and 2 are the plain courses of brickwork, forming the front of the elevation of the building. Course 3 is composed of the same class of bricks, but in this case they are laid at an angle of 45 degrees to the face of the wall, which by the formation of the internal angles form a dentil course. The form of dentil course used to be constructed largely in relation with the last few projecting courses on chimney stacks, etc. The external angle of these bricks shows a projection over the face bricks in the course preceding them. The next two courses 4 and 5, as shown in section, give the same vertical face line as the external angle line of the dentil course. The dentil course laid in this form is also known as dog's-toothing in the trade. The bricks form sharp angular projections, produced by their being laid at an angle of 45 degrees to the face of the vertical brickwork. Courses 6 and 7 are formed with moulded bricks, of which most manufacturers keep a supply. These, it will be noted, are all laid headerwise.

Weathering and Damp Proof Courses.—The top portion or horizontal surface of the wall is usually finished off with a cement and sand weathering, generally about ½ inch in thickness at the face, and 1¼ inches thick at the back face of the wall. This forms an inclined outward surface, and throws the water off clear of the face of the wall. To ensure this some of the moulded course bricks are formed with an indent or quirk on the under surface, to prevent the moisture, when dripping off, from touching the surface of the wall. In some cases this weathering is formed the reverse way, that is, from front to back. In such cases it is usual to have a vertical damp-proof course formed of asphalt on the vertical back face of the wall; the water is then thrown from the front to the back of the wall and down the asphalt surface. This is usually done when there is a flat roof at the back of a parapet wall. As a rule this is usually formed of the same surface. Sometimes the horizontal finish of the parapet wall is also finished in this way, with a layer of asphalt.

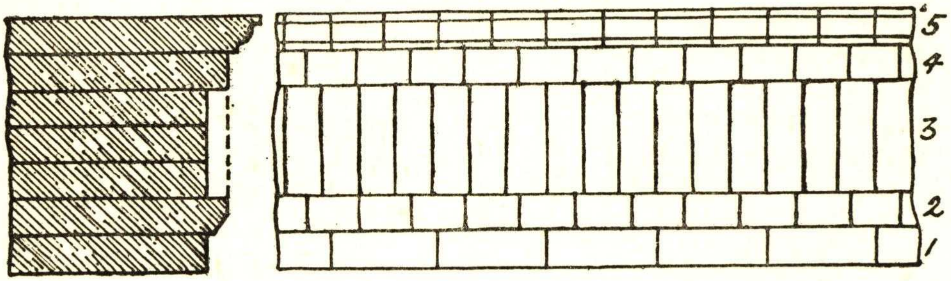


Fig. 69

Finishing Touches.—It is essential that when two moulded courses of this description are laid to form the finish of a wall, they should be well bedded in good materials and well tailed down. If all the horizontal wall joints are left open in the top course and a good layer of cement and sand laid on the top surface, it helps to insure this. It is the usual method to build two or three courses on the top of these moulded courses. These would be set back to the same face as the general face of the brickwork below the moulded courses; this would be suitable in Figs. 68 and 69 as shown.

Cornice with Sunken Panel.—In Fig. 69 we have another type of cornice. No. 1 course in the illustration shows the course in a vertical line with the general brickwork. No. 2 course is a projecting course. No. 3 in the elevation is composed of bricks, shown as headers in the shaded section, which are in a line with the vertical face of the wall, below the projecting course, No. 2. They are also laid on their ends. Above this is placed another course of headers showing the same vertical face as the course in No. 2. Above No. 4 course is a moulded projection course of headers as shown in section. Above this, and set back from the face of the moulded course, should be laid two or three courses of brickwork to tail down the weight or counterbalance the weight of the projection courses.

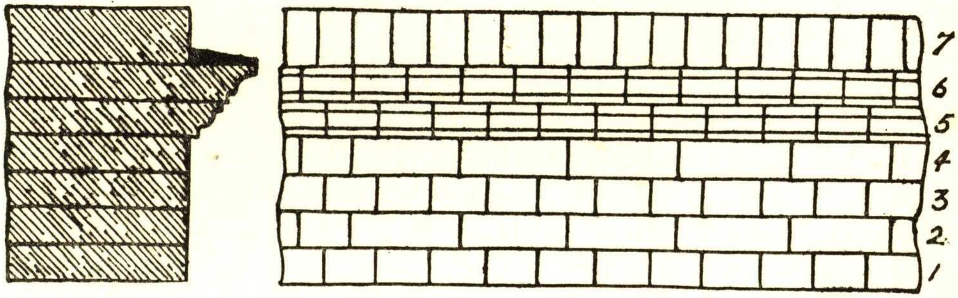


FIG. 70.

Cornice with Moulded Projecting Courses.—In Fig. 70 we have a further variation very often adopted. The courses 1, 2, 3, and 4, as shown in the elevation are the general face work construction, while 5 and 6 are composed of moulded projection courses, all laid headerwise. No. 7 is a course laid brick on edge, which is provided as a weathering course, as well as with the object of tailing down the projecting moulded courses. This course as seen in section is set back to the general line of the brickwork below, and the horizontal portion between this face and the face of the projecting moulded course is weathered by a bed of cement and sand inclined in an outward direction. The brick and edge course is sometimes weathered on the horizontal top surface in this manner, but this is not necessary if the bricks are well jointed together, as when this is the case they form quite a good weathering.

Enrichments.—It should be understood that all sections of cornices, but particularly the projecting and sunken panels, may bear enrichments, either in the form of moulded or glazed coloured bricks, or by means of gauged work. Very often too, the projecting mouldings are laid with purpose-made or rubbed bricks having a rounded or semicircular convex face, while minor mouldings may have a concave face.

CHAPTER VIII

GAUGED BRICKWORK: INTRODUCTION

Type of Bricks—Durability of Gauged Work—Mortars—Tools—Traditions and Methods

Axed work, as described in the preceding chapters on Arches and on Cornices, may be considered as the first step or introduction to the highest grade of bricklaying: gauged work. For this branch of the craft, also known as Cut or Rubbed work, special bricks and materials for bedding are required. Moreover, for this class of construction exceptional skill is necessary in the craftsman.

Type of Bricks.—For gauged or rubbed work Rubbers, or " T.L.B.'s " bricks are used. The latter term applies to a particular make of bricks, these letters being stamped on one of their faces. All these bricks are red, the tones ranging from a deep cherry red to much lighter shades. The tone of colour should be uniform throughout and the texture even, but slightly pitted as the bricks are made from clay mixtures containing a heavy percentage of fine sand. The sandy composition of these bricks enables them to be cut easily with the wire saw used by the bricklayer and also permits of their being rubbed on York Stone to a fine surface with sharp arrises or neatly rounded edges, both of which are essential in this class of work.

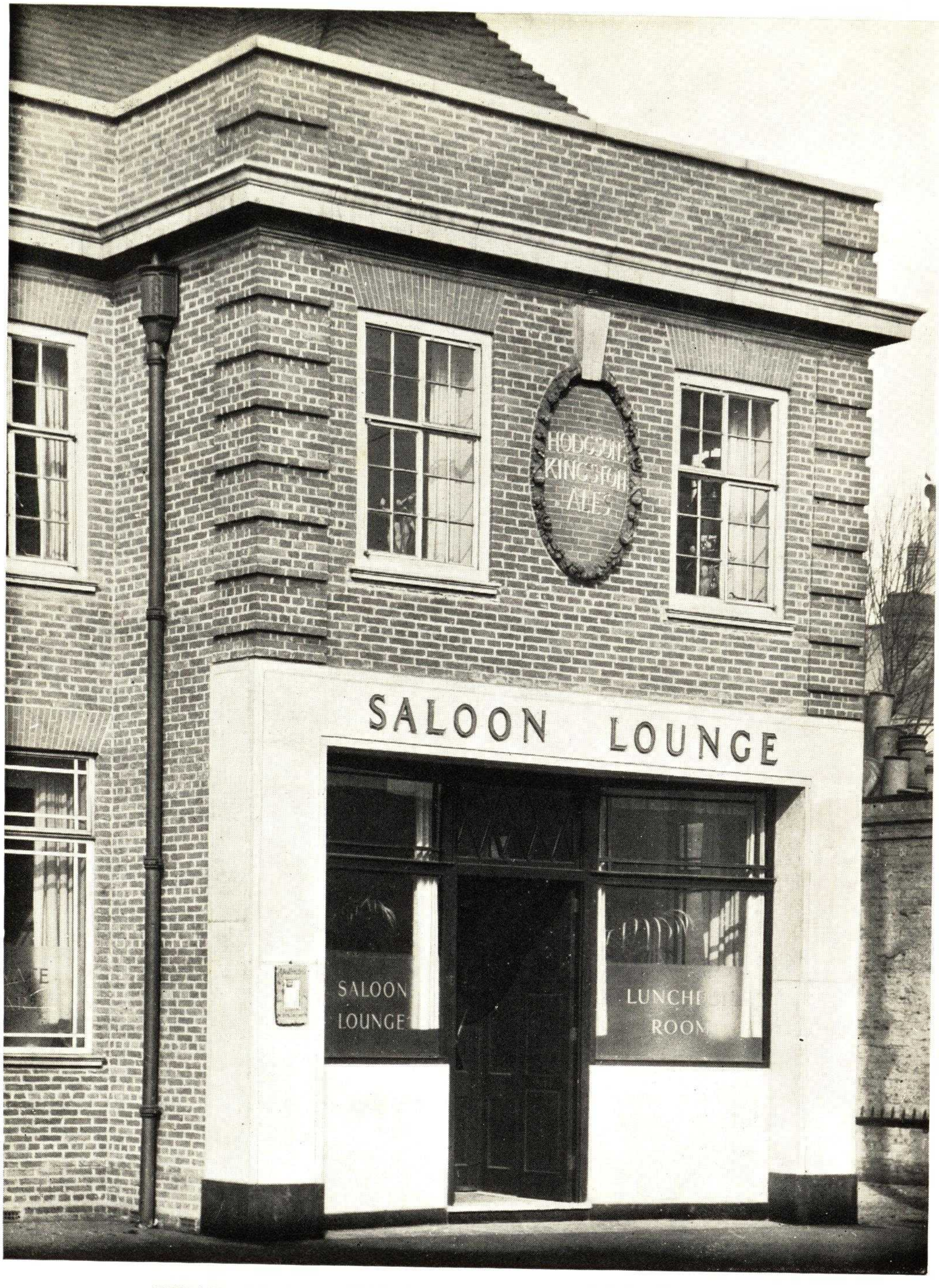
The dimensions of these bricks are usually 10½ inches in length by 4¾ inches to 5 inches in width, by a full 3 inches in thickness. But there are also purpose-made bricks moulded in longer lengths, greater widths and thicknesses, as well as other shapes, suitable for different types of arches, where generally larger bricks are needed. The crushing strength of these bricks is much lower than that for ordinary kinds, such as stocks and Flettons, being about 75 tons per square foot; they are, therefore, purely facing bricks.

As in the course of operations these bricks are cut to various sizes and angles to a pattern or template, and are also sawn in specially made boxes to different shapes, it is essential that they should be of moderate size and of a fine, even texture throughout, free from any flaws, such as cracks, vitrified parts, unburnt parts or inclusions, such as stones, ashes, etc. With inferior quality bricks too often internal flaws of the kind are met with when the saw is being operated in cutting the brick. This hardened part and air pockets, with the deviation from the true lines which they necessarily entail, may appear on the cut of a moulded face, etc., and spoil that particular brick. Such flaws also prevent proper axing and effective rubbing.

Durability of Gauged Work.—Certain critics have condemned this class of work under the belief that the bricks were of a very soft nature and would not withstand weathering. I have had the pleasure on different occasions to superintend much repair work in London, in which various examples of gauged brickwork existed. In one case several arches of this kind had to be taken out and new ones put in their places, and others repaired. This occurred on one of our prominent buildings, St. Pancras Hotel, which is a fine specimen of the Gothic style of architecture. Other good examples of the craft can be seen on the fronts of some of the fine old houses near the Chelsea embankment, and various old houses in the City of London where old gauged fronts are to be seen; such as the Temple, and also various pieces of fine work can be seen in South Kensington. When taking out these fine old arches which had been in the building a great number of years, I specially examined them and noticed that the texture of the bricks throughout was very sound and in a very good state. The outer portion, about a quarter of an inch from the face of the bricks, was very firm and solid, forming a kind of shell, slightly harder than the interior. This portion, of course, was discoloured by age and the elements of the external atmosphere. These bricks, no doubt, had hardened by the influence of the atmosphere. This proves that if such bricks are properly and solidly bedded and a good class brick is used, there is no reason to doubt why work of this description should not compare favourably with other classes of face bricks. As to case-hardening, another theory is that the silicic acid which is in the clay acts upon the chalk and forms it into a silicate of lime. This would form a siliceous or flintlike texture to the brick, thus making it of a much harder nature.

Mortars.—The most suitable materials for bedding, with the desired fine joints, are Lime Putty and also White Lead or a composition of Whiting in powdered form mixed with a patent Knotting or Shellac. Lime Putty is suitable for ashlar work, arches, etc., where the work is set and not disturbed afterwards. In the case of moulded work or carved work, where the work is first set and afterwards has to be carved, when much vibration is caused, a joint composed of White Lead and Shellac, mixed together in the form of a paste, should be used. This kind of joint possesses greater adhering power to the beds of the bricks than the Lime Putty, and withstands the vibration which is thrust upon it by the action of the carver. The thickness of the joints used in this work varies from $\frac{1}{32}$ inch to $\frac{1}{16}$ inch according to taste. Some architects prefer the bold joint to the very thin ones.

Tools.—A brief description of the tools and appliances used is necessary. Fig. 71 is an illustration of the bow saw which is used for cutting the bricks, when they are placed in their various positions in the boxes. This consists of a wood frame generally made of Ash or Beech. A stretcher bar is fixed horizontally across the middle of the frame. This is recessed into each side of the frame, but movable so



DETAIL OF BAY, THE KING'S ARMS, KINGSTON-ON-THAMES.
Joseph Hill, F.R.I.B.A., M.I.Struct.E., Architect.

that it can be taken out or in when required for the purpose of fixing the wire-cutting saw, which is fixed horizontally at the bottom of the frame. This wire saw consists of a piece of double wire, twisted, which forms small projections on its surface so as to cause a certain amount of friction when it is being pushed backwards and forwards in the operation of cutting the bricks. These fine projections make the fine cutting which is required in gauged work. The ends of the wire are adjusted by two screws, the wire being fastened round them. In the operation of fixing the wire, the top bar of the frame, a metal bar usually of wrought iron about $\frac{1}{4}$ inch to $\frac{3}{8}$ inch in thickness, is fixed through two holes in the frame and is made fast at one end by a round-headed nut at the end of the bar. At the other end the bar is provided with a long thread with a nut attached which can be regulated to tighten the frame. When the wire is placed on the frame and attached to one end and made secure, the top nut should be fully extended to allow the top part of the frame to extend outwards along the bar to its full extent. This allows the bottom ends of the frame to move in an inward direction. The wire, which has been secured at one end, should now be pulled taut and fastened at the other end in the reduced width of the frame. The top portion of the frame should now be reduced in width by screwing up tightly by the thumb nut at the end of the frame. By doing this it extends the bottom portion of the frame into its correct position and pulls the wire very tight ready for working.

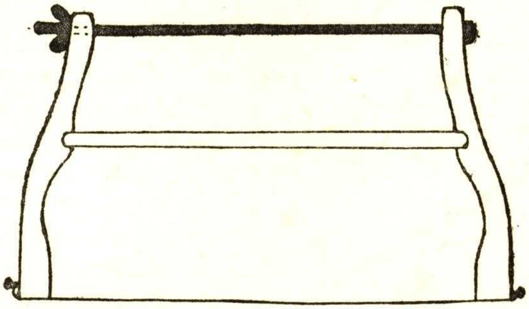


FIG. 71.

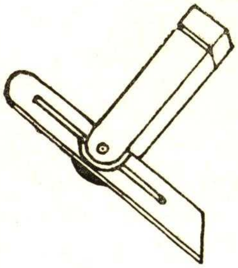


FIG. 72.

Fig. 72 shows a bevel which is used in taking off the various bevels and positions of the soffits, etc., of the bricks. This tool has been fully explained in the previous chapters on the general tools as used in bricklaying.

Fig. 73 is the illustration of a pair of compasses. These are generally made of steel, with two long arms working upon a pivot. An arm of a circular shape is fixed to one of the longer arms; this is the stationary arm, the other long arm is the movable one. This small arm attached to the stationary one is fixed for the purpose of guiding the movable arm and keeping it in various required positions. To keep this movable arm in a certain position, a small screw is attached to the small one, which passes through a hole in the long arm, and is regulated by a nut

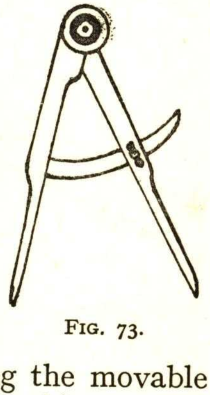


FIG. 73.

which can be turned by the thumb and finger. These compasses are used for defining measurement, and also for tracing certain measurements round the extrados line of the arch.

Fig. 74 is an illustration of the tin saw used in axed work as well as gauged rubbed work, for indenting and marking bricks. This consists of a blade about 3 inches wide and 6 inches long, fixed and slotted into a wood handle. The lower edge of the blade has a series of indentations like the teeth of a saw.

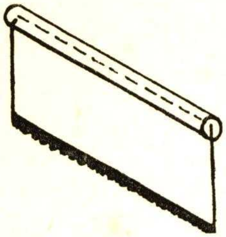


Fig. 74.

Fig. 75 is an illustration of a rubbing stone used for the purpose of rubbing the various faces and beds, etc., on the bricks. It usually consists of a good round piece of York stone, perfectly solid and not flaky. It should have a level horizontal surface to ensure a proper surface to the face of the bricks.

Fig. 76 gives an illustration of the small square used for truing up the surface of the bricks after they have been rubbed on the stone. This has been explained in the previous chapter on tools.

These are some of the chief tools used in connection with rubbed and gauged work. A small brick trowel is also used in connection with the joints of the bricks, but this has been explained previously. There are, in addition, one or two other small items such as files, which are used for finishing the various surfaces, also pieces of round metal rods sometimes used for finishing various curved faces, etc. There is also a large box required for containing the putty which is used for dipping the bricks in order to obtain the required joint. This box should be about 12 inches in depth and about 2 feet square to allow plenty of room for the bricks to be dipped into the putty. Finally there are the pincers, brush, the spirit level and straight edge, which are often required, but need no further explanation, and also various boxes into which the bricks are placed into positions for cutting; these will be described in due course.

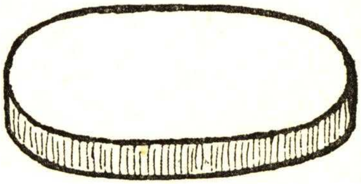


Fig. 75.

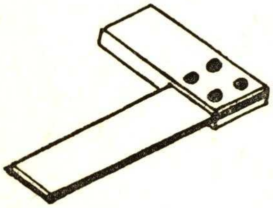


Fig. 76.

Traditions and Present Methods.—A word or two must be said about the old cutter and his surroundings, and also about the up-to-date cutting shed of the present day. There is no doubt that the craftsman of a hundred years ago worked under very different conditions to which the present-day craftsman works. There were some fine cutters in those periods, and some fine examples of their work can be seen at the present time in various parts of the country. The young craftsman of the present day has no doubt great opportunities for extending his knowledge in this particular section of his craft. In the old days cutters were looked upon in the trade as very superior beings compared with the general bricklayers. The knowledge they had of this section of their craft they usually kept to themselves, and in those days they were slow, and sometimes unwilling, to impart their knowledge to the young craftsman. Since their time, however, great strides have been made in technical education and to-day there are unlimited opportunities for the young craftsman to obtain all the knowledge he requires, and instead of working under bad conditions as the old cutter used to do, in an old shed composed probably of a few old doors, full of cracks, badly lighted, etc., with not too many tools at hand to use, and a rough bench on which to cut the bricks (though even under those conditions the old cutters turned out some fine work), he can attain all this knowledge, and at the same time work under good conditions, have plenty of tools to his hand, while the up-to-date methods are explained in a practical way. All this by attending a course on the subject at one of the building schools. He can also obtain a sound working knowledge by reading a book on the subject.

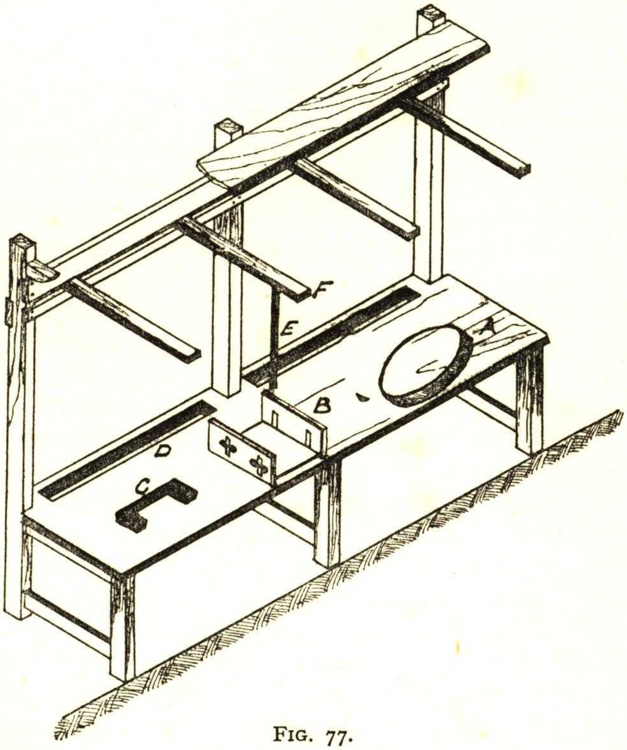


Fig. 77.

In Fig. 77 we have an illustration of an up-to-date cutting bench. This bench is fixed together firmly in such a way to withstand the vibration to which it is subjected in the numerous operations of brick-cutting. The framing of the bench is composed of 4 inches by 3 inches deal, well braced together. The horizontal part of the bench is formed of 2 inches or 3 inches yellow deal. A is an illustration of the rubbing stone seen resting on the bench. The bricks are squared and rubbed on this stone by the bricklayer placing the bed of the brick on the stone, and with his two hands on the top of the brick pushing the brick in a circular movement to the right on the stone. When the bed has been rubbed to a fine surface, one face of the brick should then be rubbed. The brick should next be squared by the bricklayer holding the brick in his left hand on its edge at a level with his eyes, and with his right hand holding the square against the two finished surfaces, the stock of the square resting against the finished bed surface, and the blade resting against the finished face surface. The brick being held in this position, the bricklayer can see if the two surfaces are at right angles to each other, or square. If the surfaces are not true, the brick has to be slightly rubbed again on the stone and retried with the square. The position of the bricklayer should be directly in front of the stone.

B is an illustration of a cutting box, into which the bricks are placed when they have been squared on the stone. The finished angle of the bricks, which have been rubbed and squared, should be placed against the internal angle of this box.

Two bricks lengthwise can be placed into the box, if the bricks are required for plain or ashlar work, the size being 9 inches by 4½ inches by 3 inches. The box can be adjusted to these sizes as it contains a movable bottom, which is elevated or lowered by the screws shown in illustration. These work the bottom of the box up and down, through the two slots on the side of the box. So if the bricks are required to be cut to a thickness of 3 inches the bottom can be moved to that measurement, and the top surface of the brick cut with the saw, on the top horizontal edges of the box. The box is placed in a position on the bench which is vertically central to the projection at F. The two bricks are placed edgeways in the box; C, which is a small piece of wood about 2 inches by 2 inches, and 6 inches in length, with two projecting pieces of the same size, is placed on the top of the bricks with straight horizontal surface upwards and the projections resting on the bricks which hold them in position. Sometimes the bottom surface of these projections are padded with a layer of felt so that when pressure is applied it does not injure the face of the brick. To keep this in position on the top of the bricks, a stretcher piece is placed on the top horizontal surface and extended to the horizontal projection piece above the box. Part of the stretcher piece is shown at E, which is shown in a vertical position over the box. This generally consists of a piece of deal about 1½ inches by 1½ inches. The top projection pieces, which extend from the back to a position vertically over the box, are composed of pieces of deal about 3 inches by 1½ inches. These are fitted tightly between two horizontal pieces of wood at the back of the bench and an allowance made for them to give a little, or extend upwards, when the stretcher piece is placed underneath, between the wood block on the top of the bricks, and the under surface of this projection piece. A number of these are shown in rotation, which enables several cutters to work on the bench at the same time. Above these projection pieces a shelf can be made for stacking the boxes, templates, etc. This shelf must be clear of the movement of the projection pieces. Again referring to the box marked B, it will be seen that it can be utilised for the finishing of the voussoirs of an arch, by moving the bottom of the box to the angle of the template which is a finished shape of the brick required. The box can be put in different positions to suit the cutter. Some cutters work the saw from back to front in a sideward movement in front of them. Others work the saw in a forward and backward movement from their left or right hand side, holding the ends of the saw with each hand. The latter movement is the best for working.

When the bricks have been sawn through on their required surface, the stretcher piece, or small block, is taken down and a final finish made with the file or a short straight edge by rubbing the bricks on the finished face in a horizontal position with the edges of the box. Sometimes the edges are encased with angle steel or tin to prevent the wooden surface from wearing away by the continual friction which is caused by the movements of the wire saw. Boxes are also made with sides which are moulded in various patterns as required. These faces are generally cut roughly with the saw and then finished to the required shape by a short straight edge or round piece of steel according to the shape of the finished moulding.

The box for the putty has already been explained. This can also be placed on the bench when ready for use. The correct way of dipping a brick into the surface of the putty requires much practice. The brick should be held by the left hand between the thumb and fingers, care being taken to hold the brick so that no arrises are damaged by touching them. It should be held horizontally level and dipped in the surface of the putty just enough to form the thickness of a uniform joint and should be taken from the surface again in a vertical position upwards. This motion leaves a square face to the putty joint. If the brick is dipped and immediately taken from the surface and turned over, it tends to make the joint of a rounded form, and when the brick is set a full square joint on the face is not obtained. When the brick has been taken from the surface of the putty in the right manner, it should be turned and a portion of the putty taken from the centre of the bed. This enables the brick to be bedded more solidly. It will be noticed when dipping a brick and drawing it vertically upwards from the surface of the putty, the material seems to collect more in the centre of the brick than at the sides of the bed, therefore forming a slight concavity which has to be removed in order to obtain a uniform thickness of beds.

A small hair brush should always be kept handy to sweep away the dust formed by the sawing of the bricks. The dust should be kept down as much as possible from a health point of view, therefore I would suggest that in modern cutting benches there should be a series of slots as shown at D at the back of the benches, in order to sweep the dust into from the surface of the benches. Under these slots there could be a number of tanks containing a small amount of water into which the dust from the slots in the benches could fall. In this way the dust would be practically eliminated as it would solidify after falling into the tanks and the benches would be kept in a better state of cleanliness. The tanks of course could be emptied at regular periods.

CHAPTER IX

GAUGED WORK: VARIOUS FORMS OF ARCHES

Parts of an Arch—Striking out an Arch—Segmental Arch—Equilateral Arch—Drop Gothic Arch—The Lancet—Rampant Arch—Semi-circular Arch—Bull's-eye or Wheel Arch—Horseshoe Arch—Semi-Gothic Arch—Segmental Gothic Arch—Straight Arch—Scheme Arch—Semi-ellipse—Three-centred Arch—Drawing an Ellipse with Pencil and String—Freehand Drawing of an Ellipse—Use of the Trammel—Four-centred Arch—Camber Arch—Venetian or Queen Anne Arch—Moulded Arches—Forming Bevels.

SOMETHING has already been said about the importance of arches, and the part they play in structural work. Here we are more concerned with the decorative side of the subject as well as the intricate details connected with the building of the more complicated types, and this necessitates a knowledge of the various sections which go to make up the complete arch.

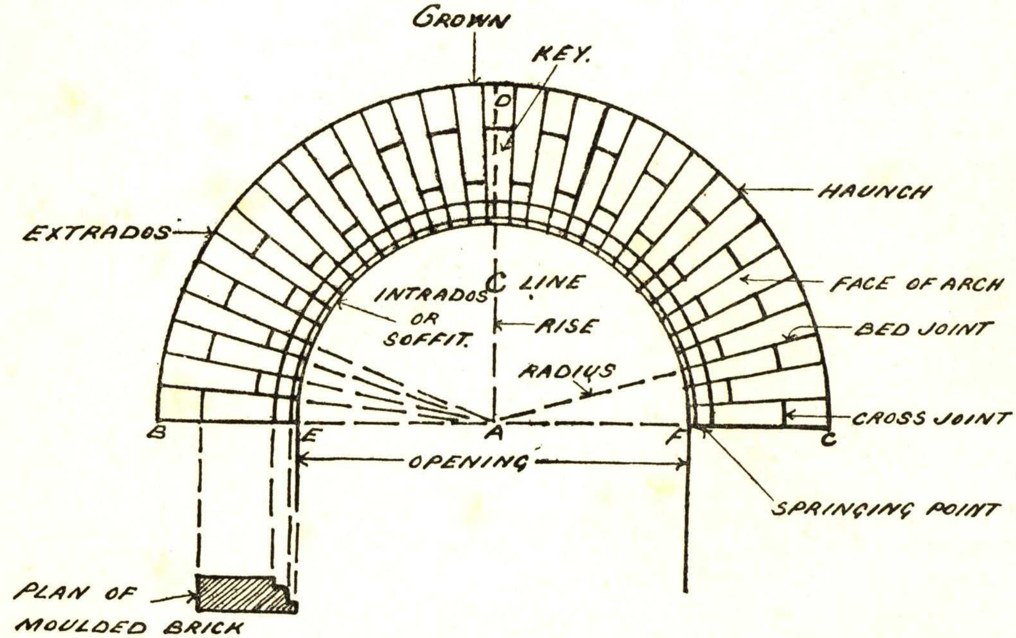


FIG. 78.

Parts of an Arch.—In Fig. 78 we have an illustration of a semi-circular arch with a $2\frac{1}{4}$ inches moulded soffit, showing the opening. The vertical side walls are the piers, and the inner curve spanning the space between these piers is known as the intrados, the outer curve of this framing to the opening is the extrados, while the under space or ceiling, as it were, between the inner and outer intradoses, is the soffit. The springing point of the arch is that part where the actual curve begins; the haunch a horizontal. The haunch, or flank, is that section between the springing points and the voussoirs.

The base line is a horizontal line at the base of the arch, extending the whole length of the opening. The *striking point* is placed in the centre of this line at A, for the purpose of scribing the intrados and extrados curves. The *rise of the arch* is the vertical distance between the striking point or the centre of the base line, and the highest point of the intrados. The *crown* is the highest point of the extrados. The wedge-shaped constructions which form the arch are known as *voussoirs*, and lie between the springing and the *key*, which is the centre brick, or voussoir of the arch. *Springers* are the lowest voussoirs of the arch. The vertical distance from the springing to the crown of the soffit at the key point, is the rise. The *bed joints* are the joints which are made normal to the curve of the arch, the length of which extends from the intrados to the extrados and also extends from the external face to the back of the arch. *Cross joints* are those which extend between the bed joints, as in the semi-circular arch, as shown they show in a right angle from the bed joint. The plan of the moulded brick is shown, the dotted lines projecting from the elevation to this plan.

Striking out an Arch.—The striking out of the arch consists of drawing a horizontal base line from B to C. Then obtain the centre of this line, and mark it with a point at A. From point A a perpendicular line is drawn at right angles to the line BC. This perpendicular line should be extended to D. Then with the compass point at A, and radius equal to the distance AE, scribe a circle from the springing point E to the springing point F. This forms the intrados curve of the arch. Then take a horizontal distance on the base line to the left and right of points E and F to B and C. This distance is 13½ inches, or the depth of the face of the arch. Next, with the compass point again at A and extended to B, the distance of which is equal to the radius which forms the outer semi-circle or extrados curve, with the compasses draw from point B to C to form this outer semi-circle. Further proceed to trace the bricks or voussoirs of the arch round the extrados curve. A measurement must be taken from the 2-foot rule, which equals the top face width of a voussoir when finished, say for example, 2½ inches. This width of face when finished allows for all the cutting and rubbing that has to be done before the brick is finally shaped to the template or mould. This measurement can now be adjusted from the rule to the compasses by placing the compasses at an equal distance each side of the centre line. This measurement must then be traced round with the compasses until the last measurement finishes exactly on the horizontal springing of the arch. The number of voussoirs as shown on the diagram, each side of the key brick, is sixteen. By having this even number of bricks each side of the key brick permits of a stretcher on the face, or whole brick forming the key, while a whole brick also forms the springing brick of the arch. If not finishing with the compasses, after tracing round the extrados at the springing point, the compasses should be adjusted to a smaller or larger measurement as required and traced round the extrados curve once more. This is a very important point in setting out the work as it is essential that all the voussoirs should be exactly the same measurement. Having traced all the voussoirs points correctly, lines can then be drawn from these points on the extrados curve to the intrados curve, radiating to the centre of the opening, or the striking out point of the arch, which is marked A. These lines represent the bed joints of the arch bricks. The cross joints can next be drawn in their correct position by placing the compasses again on the same striking point at A, and scribing them round parallel to the two curves.

This semi-circular arch also shows a moulded soffit, the plan also being shown. This moulding can be drawn on the elevation by projecting the points from the plan and then with the compasses forming the lines round the semi-circle as shown. This completes the setting out of the semi-circular arch. The semi-circular arch is one of the simpler kind to set out, the whole of it being struck from one point.

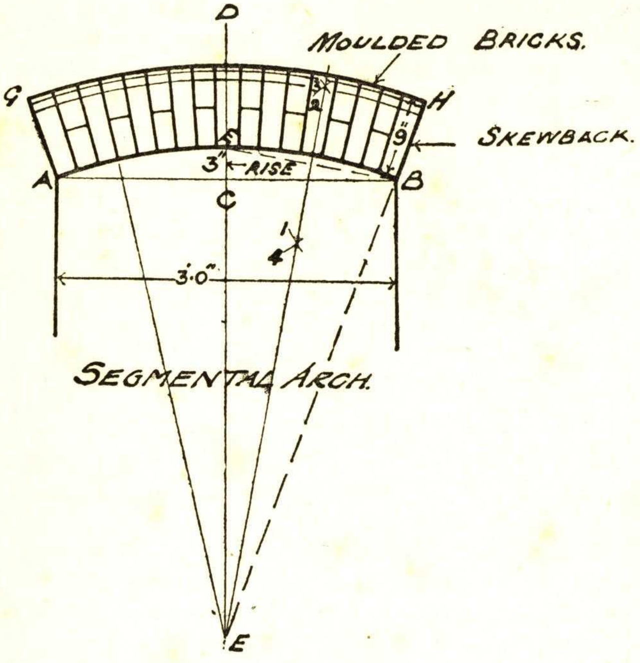


FIG. 79.

Segmental Arch.—Another arch of this kind is the *Segmental Arch* as shown in Fig. 79, which is in the form of an arc. This is also struck from one centre. The opening in this case is 3 feet in width. The base line should be drawn first from A to B. Then define the centre point on this line, which is at point C. At this point draw a centre line at right angles to AB, and extend it above to D and below to E; from point C take a measurement of 3 inches upwards, which is the rise of the arch. This is point F. Connect F and B by a dotted line; then bisect the line FB. This is done by placing the point of the compass on point B and taking any distance more than half of the line FB, and then scribing an arc, the ends of which are shown and marked 1 and 2. Next place the compasses on point F and repeat the operation. The ends of this arc cut the previous one and are shown at 3 and 4. Through these intersection points of the two arcs, draw a line and extend it till it cuts the centre line at point E. This forms the striking point of the intrados and extrados curves of the arch. Then place the compass points on point E and extend to A, and draw an arc to B. This forms the intrados curve. Again place compass points at E and extend it another 9 inches to point G, and draw an arc from this point to H. This forms the extrados curve of the arch. The skewback can now be formed by drawing a dotted line from the striking point at E and extending it to H. Then a plain line can connect B to H, which forms the skewback. The points for the voussoirs can then be marked out in their correct position and lines drawn on the face of the arch to represent their positions, radiating from point E.

Moulding can be used with this form of arch, either on the soffit, or on the face of the arch, forming a face moulding 2¼ inches from the top of the voussoirs as shown in the illustration.

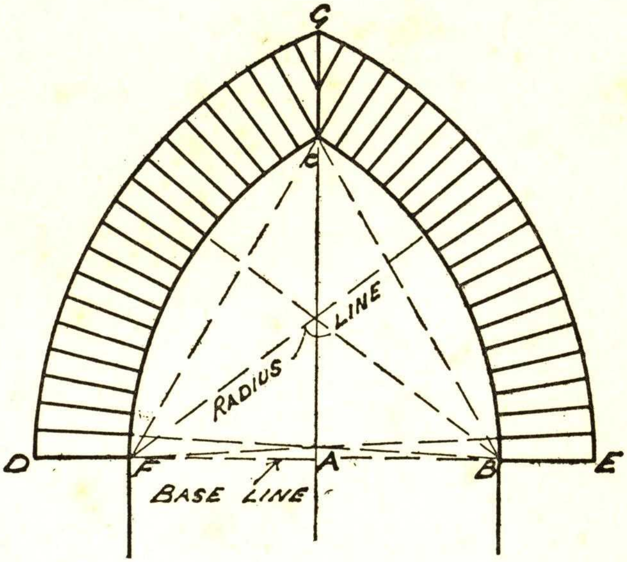


FIG. 80.

Another simple form of arch is the Gothic. This is composed of two arcs and is struck from two striking points.

Equilateral Arch.—Fig. 80 is an illustration of the equilateral Gothic arch of which the three points, viz. the two springing points F and B and the soffit point of the arch at C, when joined together form an equilateral triangle. To set out this arch draw the base line D to E. Mark off along this line the width of the opening which extends from F to B. This is 3 feet in width. Measure off and define the centre point of the opening along the base line, which is at A. Then from this point draw a perpendicular line at right angles to the base line, and extend to point G. Then with compass point at B and extended to F, draw the left hand side arc from F to C. This forms the left hand intrados curve of the arch. Again with compass point at B and compass extended a further 9 inches to point D, which forms the face of the arch, draw an arc from point D to G. This gives us the extrados curve of the left hand side of the arch. From C to G draw a plain line, which forms the centre point of the arch; space out points for voussoirs, and draw them with plain lines, radiating from point B. The dotted lines just above the base line show the radiating lines from points B and F to the soffit points of the bricks in the arch. This completes the left hand side of the arch. The right hand should be treated in a similar manner, the striking and radiating point for arch bricks being at F.

The Drop Gothic Arch.—Fig. 81 is an illustration showing the elevation of the Drop Gothic Arch. Draw the base line B to C, the centre of which is point A. Measure a distance 18 inches each side of the centre point to form the three-foot opening of the arch, points at D and E which form the springing of the arch. Divide the base line between D and E into four equal parts of nine inches each; take the two middle parts, and place one each side of the centre point, from the centre point at A erect a perpendicular line and extend it to point F. The four equal divisions in which the base line is divided work out correctly for an arch with this rise. If the opening was the same width as this one, viz. three feet, and the rise of the arch was two feet, instead of 2 feet 1½ inches as shown, the ordinary method would be used by joining the base points D and E to I and then bisecting the lines DI and EI, and then extending the bisection lines of these two until they cut through the points at the base line. These points are the striking points of the arch. This method of bisecting is shown in line No. 1 when the bisection line cuts the base line at point G. This forms the striking point of the arch, which has the 2 feet 1½ inches rise. Line No. 2 as shown forms the line from E to a point 1½ inches less than No. 1 line, or a point 2 feet above point A. The intersecting line through this line extended to the base, cuts the base line at a point marked with a cross. Thus it will be seen that the smaller the rise of the arch the nearer to the centre on the base line will be placed the striking points of the arcs which form the shape of the arch. Therefore, place the compasses on H and extend to point D, and scribe an arc from D to I, which forms the

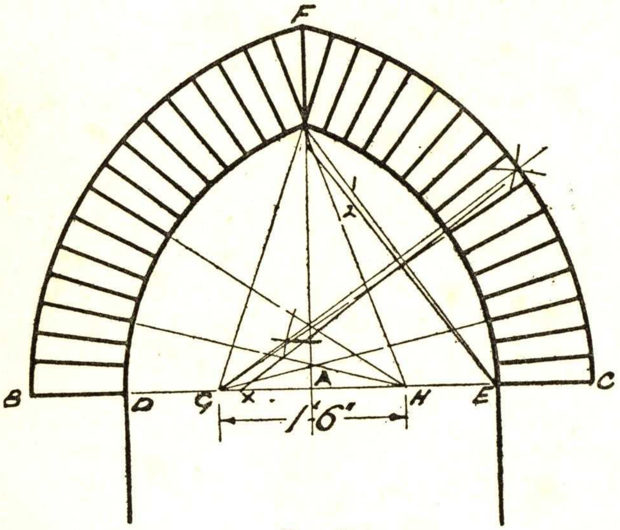


Fig. 81.

left hand arc or intrados curve. Then extend the compasses another 9 inches and from the same striking point at H, scribe another arc from B to F. This forms the extrados curve of the left hand side of the arch. The lines which form the voussoirs are radiated from point H, for the left hand side of the arch. This completes the left side of arch. The striking of the arcs and the formation lines of the voussoirs for the right hand side of the arch, are radiated from point G along the base line. This completes the striking out of the Drop Gothic Arch.

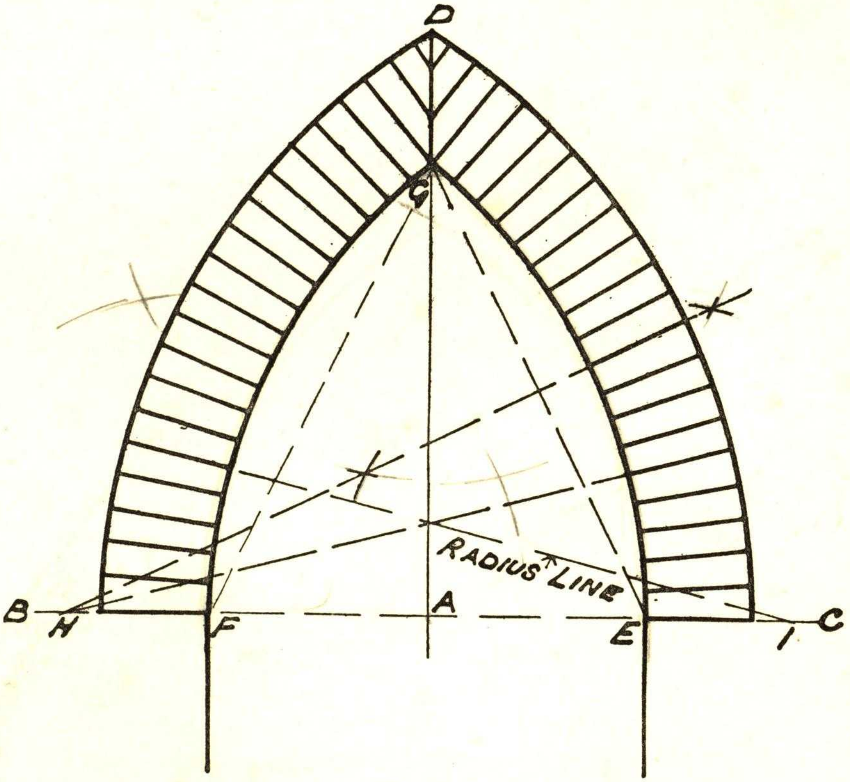


FIG. 82.

The Lancet.—Fig. 82: this illustration shows another form of the Gothic Arch known as the Lancet, in which the rise of the arch is of a greater length than the opening. The opening in this case is 3 feet in width, and the rise of the arch is 3 feet 1½ inches in height. To strike out this arch draw a base line B to C. This should be long enough to include the two striking points, which are this time outside the width of the opening. Place the length of the opening on the base line, which is 3 feet; divide this into two equal parts, and mark a centre point as shown at A. From this point erect a perpendicular line at right angles to base line and extend to point D. From the centre of the base line at point A measure a perpendicular distance of 2 feet 1½ inches, which is the rise, terminating at point G. Connect E to G and F to G; bisect the line EG, of which the bisecting line will cut a point in the base line at H; then connect points F and G, bisect this line and the extension of the bisection line will cut the base line at point I. These two points H and I are the striking points for the intrados and extrados curves of the arch. The same method for striking these curves will be used as in the preceding arch, viz. point H will be the striking point for the right hand side curves of the arch, and point H will again be the radiation points for forming the right hand side voussoirs. The left hand side is drawn in the same way from point I. The springing points of the arch are at F and E. The depth of the face of the arch is 9 inches. The perpendicular line from G to D forms the centre vertical joint of the arch.

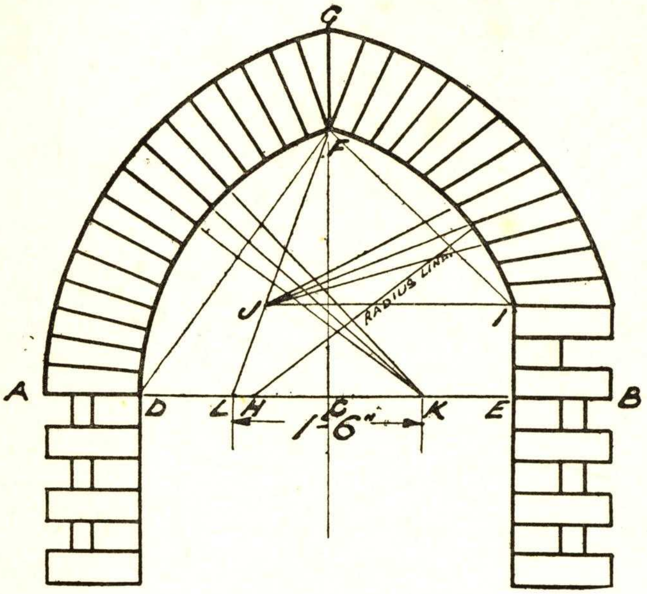


Fig. 83.

Rampant Arch.—Fig. 83 is an illustration of another form of arch, known as the Rampant Arch, in which one springing of the arch on the left is at a lower horizontal level than the springing on the right hand side. First set out the base line AB; measure off at each side of the centre point 18 inches, which measures three feet. This gives us points D and E, which is the width of the opening. From the centre point C erect a perpendicular line at right angles to the base line, and measure up the given rise, which is 2 feet 1½ inches. Mark the point F and continue this perpendicular line to point G. Then connect D to F, bisect this line and continue the bisection line until it cuts the base line at point K. This point forms the striking point for the intrados and extrados curves, which form the left hand side of the arch. The same point H also forms the radiation lines which form the voussoirs in the left hand side of the arch. The right hand side of the arch is 9 inches higher than the left hand side; therefore, from the springing point I to F draw a working line; bisect this and extend the bisection line until it cuts the base line AB at the point H. This point forms the striking point for the intrados and extrados curves, which form the right hand portion of the arch. The radius line from point H, which forms the curves of the right hand side of arch is shown. The striking point, which forms the lines of the voussoirs in the right hand side, is radiated from point J. The striking point J is obtained by first measuring a distance of 9 inches to the left hand side of the centre point at C, which is equal to the distance of C to K. This gives us a point L; connect L to F by a working line; then draw a horizontal line at a level with the right hand springing of the arch, from I to J. Thus J is obtained at the point where the horizontal line at a level with the springing cuts FL. From this point at J all the lines which form the voussoirs in the right hand side of the arch are radiated. This completes the striking out of this form of arch. The face of the arch is 9 inches in depth, F to G forms the straight vertical joint of the arch.

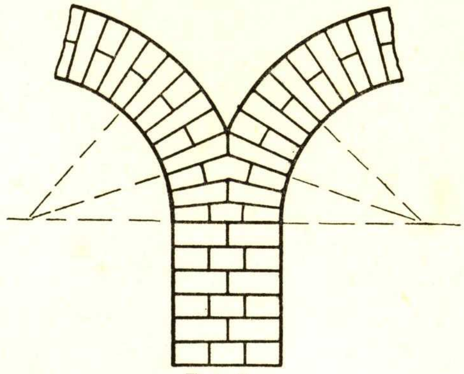


FIG. 84.

Semi-circular Arch.—Fig. 84 is an illustration showing the intersection of two semi-circular arches built upon a 14-inch pier. The method of striking out the two semi-circular arches has already been fully explained. The angular shaped portion of brickwork between the two arches is called the spandril. The extrados curves in this case do not extend to the springing of the arches; they form a V-shape connection by the two extrados curves meeting at a point about 12 inches above the springing points of the two arches, and the bond continued down to the top of the pier, which forms a base for the intersection of the two arches.

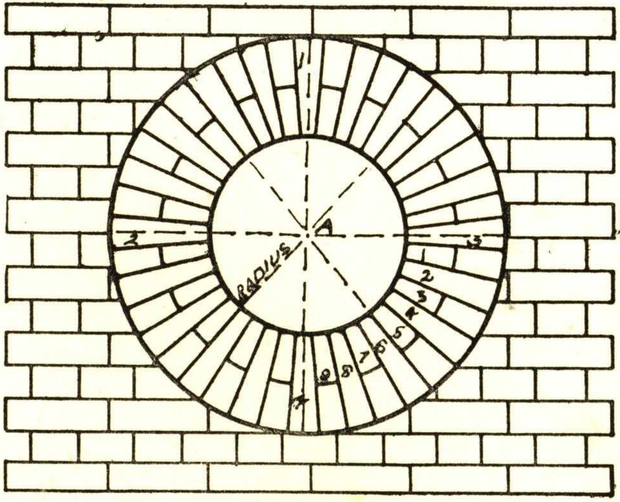


FIG. 85.

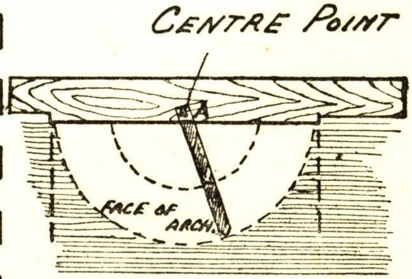


FIG. 86.

Bull's-eye or Wheel Arch.—Fig. 85 is another form of the semi-circular shaped arch. In this case we have the two semi-circles placed together forming a complete circle. This arch is also struck from one striking point and is known as the Bull's-eye, or as it is sometimes called, the wheel arch. The striking point for the intrados and extrados curves which form the face of the bull's-eye is at A. All the lines forming the voussoirs are also radiated from this point at A. The points for the positions of the voussoirs are marked on the extrados curve in the same manner as previously explained. The key bricks are marked as shown, 1, 2, 3, and 4. The number of voussoirs between each key brick is 9, an odd number. In the case of the semi-circular arch the number of voussoirs each side of the key is an even number.

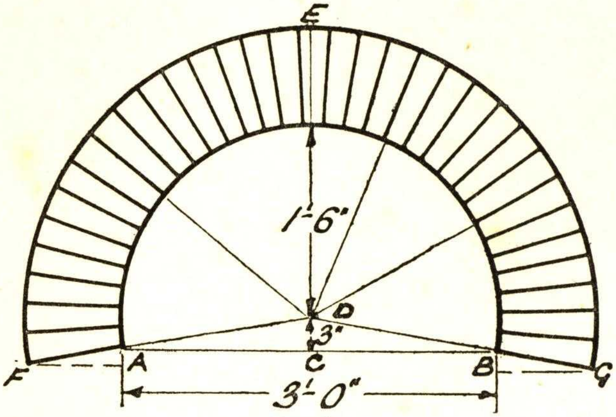


Fig. 87.

Fig. 86 is an illustration showing the method of forming the semi-circular base for the lower part of the bull's-eye arch. A piece of 4 inches by 3 inches is usually placed in a level horizontal position over the opening in which is to be placed the bull's-eye. The 4 inches by 3 inches is shown placed in position, with the trammel rod nailed to point A, by rotating which all the bricks are marked and cut to the semi-circular position of the bottom dotted circle. The rod can be shortened for the inner circle of the arch.

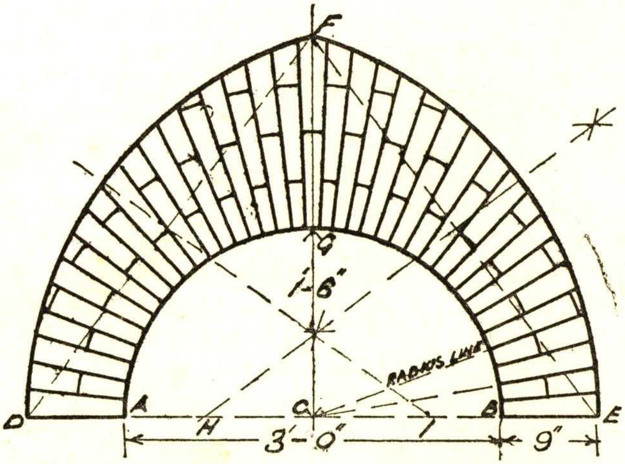


Fig. 88.

Horseshoe Arch. Fig. 87 is an illustration showing another form of the semi-circular arch known as the Horseshoe Arch. The base line in this case is the horizontal line AB. From the centre point of the opening at point C erect a perpendicular line at right angles to the base line AB, and extend it to point E. Take a measurement of 3 inches in a perpendicular direction from point C to point D. This point D forms the striking point of the intrados and extrados curves of the arch. The extrados curve should be extended below the base line to points F and G; 1 foot 9 inches is the height of the rise. All the lines which form the voussoirs on the face of the arch are radiated from the striking point at D. The spacing of the voussoir points on the extrados curve of the arch is formed by the method as stated previously.

Semi-Gothic Arch.—Fig. 88 is an illustration of the Semi-Gothic Arch. The intrados curve is formed by a semi-circle and the extrados is formed of two arcs in the shape of the drop Gothic form of arch. Draw the base line from D to E; find the centre of the base line, which is C; take 18 inches each side of point C, which forms the 3-foot opening of the arch, and from point C erect perpendicular line at right angles to the base line DE. Extend this line to point F. From point C with the compasses extended to A, scribe a semi-circle from A to B. This forms the intrados curve of the arch. Then connect points E to F and D to F by working lines; bisect EF and DF. Where these bisection lines cut the base line at points H and I, will be the striking points for the extrados curves of the arch; H will be the striking point for the right hand extrados curve, and I will be the striking point for the left hand extrados curve. The rise of the arch is as in the semi-circle; that is, the height or rise is equal to half the width of the opening—in this case the rise being 18 inches. The lines which represent the various positions of the voussoirs on the face of the arch are all radiated from point C. The radiating line from this point to the face of the arch is shown in the illustration.

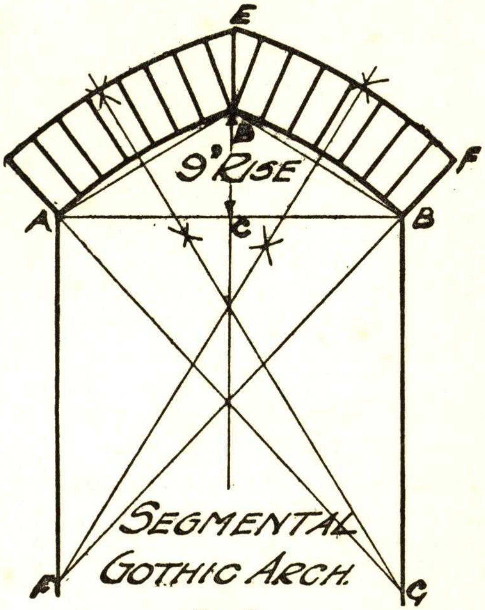


FIG. 89.

Segmental Gothic Arch.—Fig. 89 is an illustration showing the form of arch known as the Segmental Gothic Arch. Draw the base line from A to B; find the centre of the opening, which is at point C; extend the two perpendicular lines at each side of the opening downwards from A to F and B to G. Erect a perpendicular line in the centre of opening at point C to E. Take a distance of 9 inches upwards from point C on the base line to D. This distance forms the rise of the arch. Connect B to D and A to D by working lines; bisect these two lines and extend the bisection lines until they cut the perpendicular lines on each side of the opening at the points F and G. Point F forms the striking point for the intrados and extrados curves of the right hand side of the arch, by placing the compass on F and extending it to E, and drawing an arc to point D, also again placing the compass at point F and extending it to point F^1, and drawing an arc to point E. The lines which form the various positions of the voussoirs on the face of the right hand side of the arch are radiated from the same point at F. The left hand side of the arch is completed by the same method. This arch shows the same vertical centre joint as in the Gothic Arch.

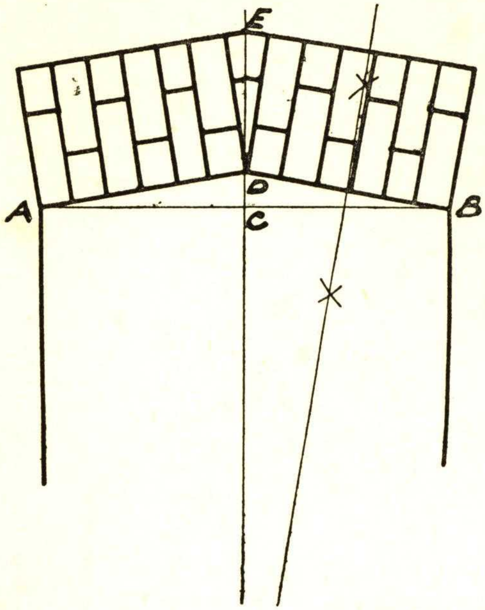


FIG. 90

Straight Arch.—Figure 90 is an illustration of a form of straight arch, with a 3-inch rise. Draw the base line AB, erect a perpendicular line at point C at right angles to the base line C to D. From the rise of the arch, extend D to E. This forms the centre line of the arch. The key of this arch is formed by the wedge-shaped stretcher and header as shown. All the arch bricks are of the same parallel thickness, and at right angles with the soffit of the arch. In the case of the segmental arch the line BD would be bisected, and the striking point would be the point where the bisection line cut the centre line. In this case there is no need for this, as the soffit of the arch is formed in two straight lines.

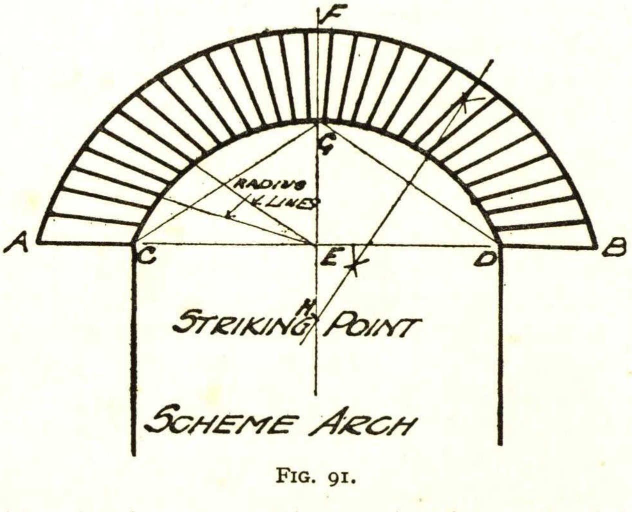


FIG. 91.

Scheme Arch.—Fig. 91 is an illustration of the Scheme Arch. The intrados and extrados curves of this arch are struck from one point, and the radiation of the lines on the face of the arch which form the voussoirs are radiated from another point. The arch in the illustration has an opening of 3 feet, and a rise of 12 inches. Draw the base horizontal line AB; define the centre at point E; take a distance of 18 inches each side of this centre point, which forms the left and right hand side of the opening at points C to D. At point E erect a perpendicular line at right angles to AB, and extend it to point F.

Then again, from point E on the base line, take a measurement of 12 inches upwards to point G. This forms the rise of the arch. Then connect D to G, and C to G by working lines; bisect these two lines and extend the bisection lines until they cut the centre line at point H. This is the striking point as marked. Place compass on H, extend to point C, and draw the arc which forms the intrados curve of the arch from C to D. Then with compass point again at point H, and extended to point A, draw from this point to B. This forms the extrados curve of the arch. The lines on the face of the arch, which form the position of the voussoirs, are radiated from point E, which is on the horizontal base line.

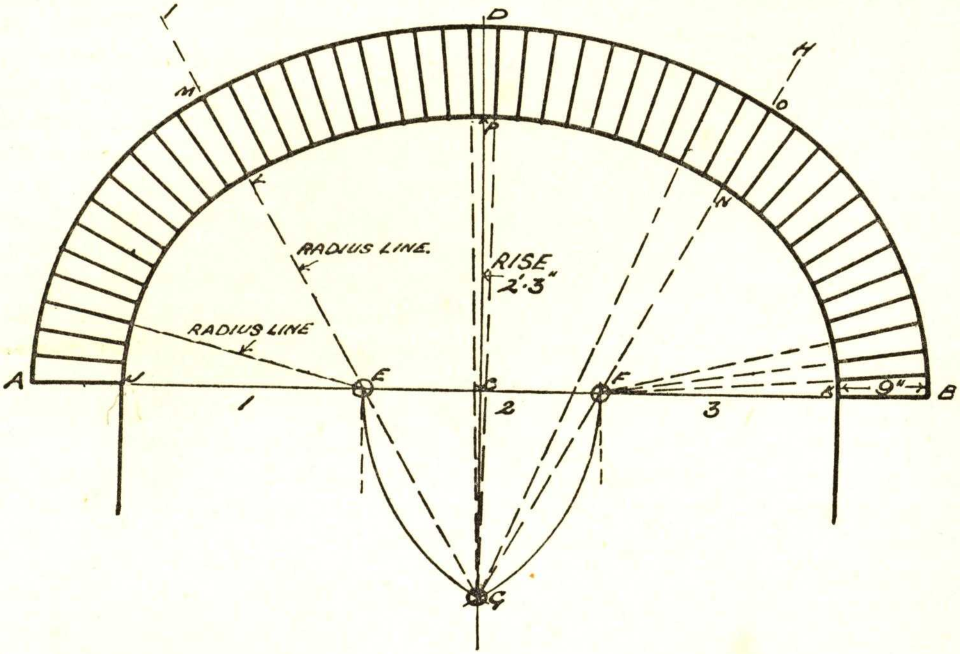


FIG. 92.

A Semi-Ellipse.—Fig. 92 is an illustration showing the method of drawing the semi-ellipse. From three centres draw the horizontal base line AB. Define the centre point along this line at point C. This forms the centre of the opening, which is 6 feet in width, therefore take a measurement of 3 feet each side of the opening, and the extra 9 inches on each side of the opening forms the face width of the arch. Erect a perpendicular line at point C at right angles to the base line, and extend upwards to D and downwards to point G. Now divide the 6-foot opening into three equal parts of 24 inches each; by so doing this will give us the two striking points E and F on the base line. Then place the compass on point F, extend to point E and draw an arc to G where the arc cuts the centre line. Then, again, with the compass at point E, and extended to point F, draw another arc from F to G. This arc should cut the centre line in exactly the same points at G where the arc FG does. This gives us the third striking point of the arch. Now draw a working line from point G to H, cutting through point F. Also draw another working line from G to I, cutting through point E. These two lines G to H and G to I divide the curves of the arch into three divisions, viz. the centre and two side portions. These lines are placed in position which form the connecting points of the large and small curves which form the arch. The side portions of the arch can now be drawn by placing the compass on point E, extending it to J, and drawing an arc to L. This forms the intrados curve of the left hand side portion of the arch. Then again, with compass placed at point E and extended another 9 inches in length, which forms the face of the arch, draw an arc from point A to M. This forms the extrados curve of the left hand side portion of the arch. Then, again, with the compass placed on point G, and extended to L, draw an arc to N. This forms the intrados curve of the middle portion of the arch. Again with the compass at point G and extended to M, draw an arc from point M to O, passing through D, which forms the centre line of the arch. This forms the extrados curve for the middle portion of the arch. The left hand side portion and the middle portion of the intrados and extrados curves have now been drawn. The right hand side portion can be carried out in the same manner as the left, which will then connect the curves at points N and O to complete the curves of the arch. The lines on the face of the arch on the left and right hand portions of the arch form the position of the voussoirs and are radiated from point E for the left hand portion, which is marked, showing the radius lines, and point F for the right hand portion. The radiating of the lines, which form the voussoirs in the centre portion, are taken from point G on the lower portion of the centre line. The rise of the arch is 2 feet 3 inches. This completes the setting out of this arch.

Three-centred Arch.—Fig. 93 is an illustration showing another method of striking out an ellipse or three-centred arch. Draw the base line AB, find the centre point at E; take 2 feet each side of the centre point on the base line, which forms the 4 feet opening from point E, erect a perpendicular line at right angles to the base line AB, and extend to M in an upward direction and to N in a downward direction. Divide the horizontal base line into four equal parts of 12 inches each. This gives us the position of two of the striking points of the arch, viz. C and D. Now, with the compass on the centre point of the base line at E, and extended to G, draw a semi-circle from G to H, at the same time cutting through the centre line. The point where the semi-circle cuts the centre line at N is the third striking point. The three striking points are denoted by three small circles. Next connect N to D and continue the working line to point K. Also connect N to C and continue this working line to L. These two lines again divide the arch into three divisions, viz. the two ends and the middle section. The rise of the arch in this case is 1 foot 3 inches from the base line. The striking points therefore for the two side portions of the arch are C for the left and D for the right. The lines which form the positions for the voussoirs on the face of the arch are also radiated from points C and D for the left and right hand sides. For the middle portion the striking point is at N. This will form with the compass extended to I and L the intrados and extrados curves, which form the middle portion. These two curves as shown will extend to J and K, and form the connecting points into the sharpened curves at the side section of the arch. The lines which form the portions of the voussoirs on the face of the arch in the midde portion are radiated from the striking point at N. This completes the setting out of this arch. The positions of the voussoirs are divided out by the same method as explained previously in the extrados curves of the arch.

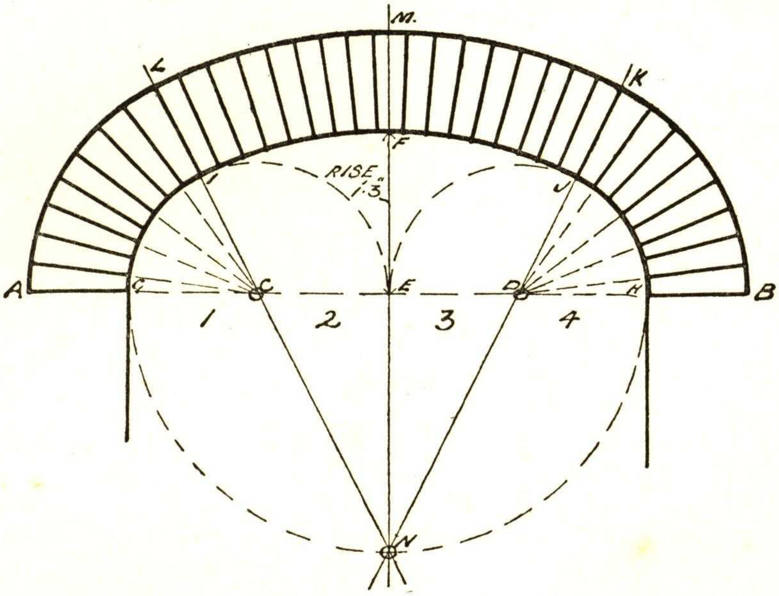


FIG. 93.

Drawing an Ellipse with Pencil and String.—Fig. 94 is an illustration of a semi-ellipse which is drawn by the use of a pencil and string. This is also a three-centred arch. The base should be drawn AB. The centre line should be marked at point E, and a perpendicular line at right angles to the base line should be drawn extending to H upwards and to F downwards. The width of the opening should then be set out by two equal measurements at each side of the centre point E. A distance of 6 inches from each side of the opening should be taken towards the centre point E. This gives us the points I and J. Wire nails should now be driven in at points I and J. The rise of the arch should now be marked at point G, which is 12 inches in a vertical direction from the base line AB. A string should then be tightly drawn round the three points I, J, and G. At this last point there should be a temporary nail which should be withdrawn after the string has been drawn round the three points and made fast in the shape forming a triangle, and a pencil put in its place. The pencil should then be moved round on the surface of the paper, all the time keeping the triangle which is formed by the string in a taut position. Nos 1, 2, and 3 show the various positions of the string which has been moved in drawing the pencil along to form the intrados curve of the arch. The extrados curve can be drawn in the same manner by three points at I, J, and H. For the purpose of drawing the lines on the face of the arch, indicating the position of the voussoirs, the radiation point from which they are formed is similar to the preceding arch. That is to say, the points which form the radiation for the lines showing the positions of the voussoirs on the face of the arch, for the left and right hand sections are the points I and J on the base line, and F for the centre portion of the arch. F is obtained by placing the compass on point J and extending to I and drawing an arc from I until it cuts the centre line at

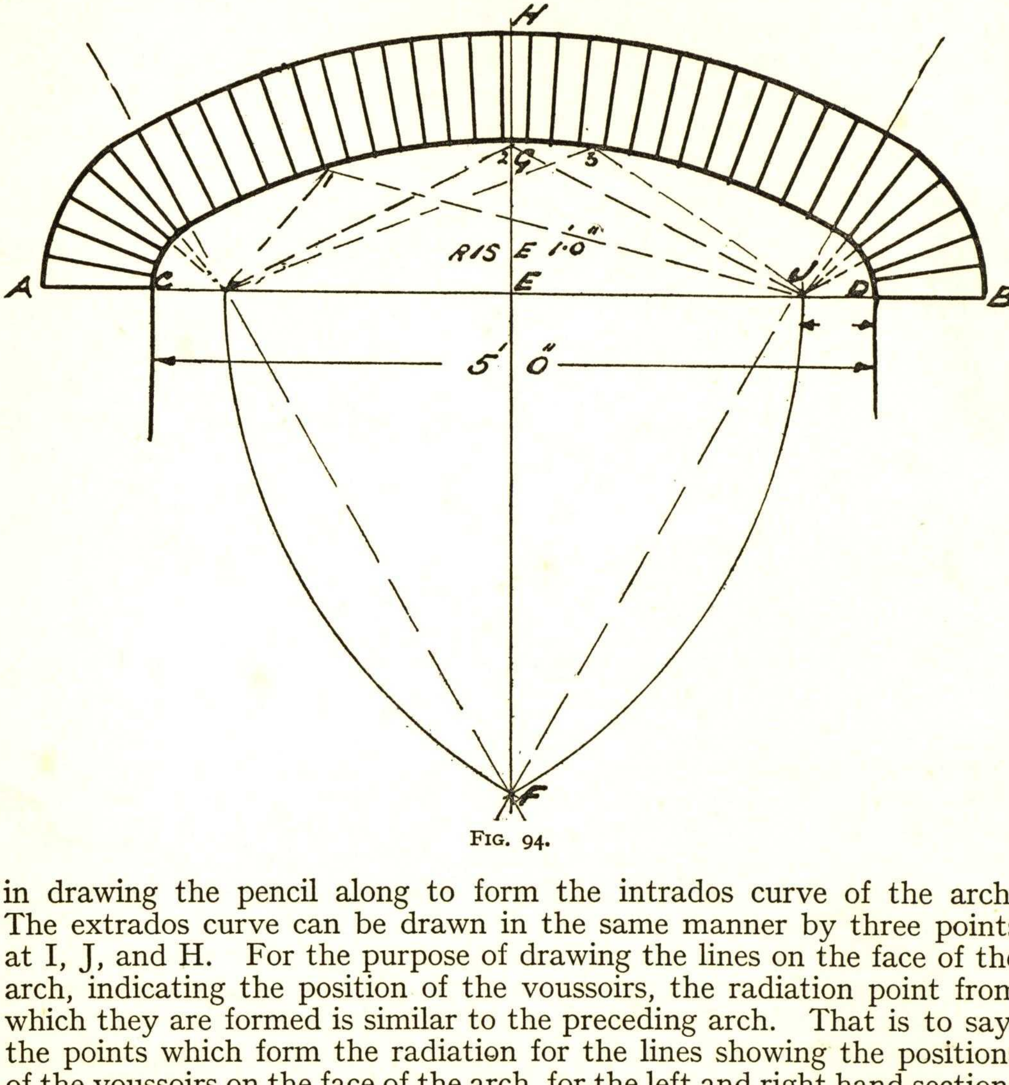


FIG. 94.

point F, and again placing the compass on point I and extending to J, and drawing an arc from J to a point where it cuts the centre line at F. These two arcs should cut the centre line at exactly the same point at F.

Freehand Drawing of the Ellipse.—Fig. 95 is an illustration of another method of drawing the semi-ellipse by freehand to a series of points. Draw a horizontal base line AB, which forms the width of the opening which is 6 ft. Find the centre point of the base line at point C. This is AB divided into two equal parts. From points AB and C on the base line erect perpendiculars at right angles to the base line and extend them to a height of 18 inches to points DH and E. These connect together and form the top horizontal line. From the points A and B on the base line draw a perpendicular line downwards to points F and G for a distance of 18 inches. These working lines now form two oblongs. Extend the centre point C vertically downwards to point I, on the bottom horizontal line. The base line AB should now be divided into twelve equal parts, that is six equal parts on each side of the centre point C. Then divide AD and EB, which form the small sides of the oblong, each into six equal parts; that will be equal divisions of 3 inches each. On the left hand side the vertical line AD shows the six equal divisions marked on the right-hand side. The vertical line BE shows the points of the divisions which are marked, starting from the base line upwards, 1, 2, 3, 4, and 5, connect these division points 1, 2, 3, 4, and 5 to point H by dotted or working lines. Then from point I on the centre of the bottom horizontal line, draw working lines through the division points of the base line AB and extend them until they reach the working lines which were drawn from point H to the vertical division points on the

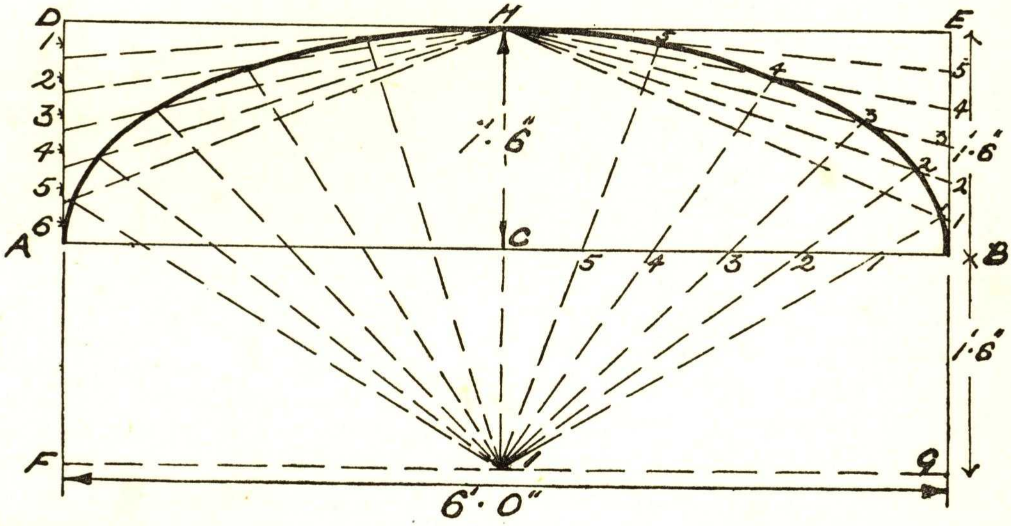


FIG. 95.

side of the oblong above the base line. Therefore, the first line from point I passes through point I on the base line AB and touches the line HI at point I on that line. Again the second line from I passes through point 2 on the base line AB and touches line H2 at point 2 on that line. These points should then be joined together as shown on the curve of the ellipse and marked 1, 2, 3, 4, 5, and from point 5 to H. The other side of the arch can be done by the same method being used to complete the curve of the semi-ellipse.

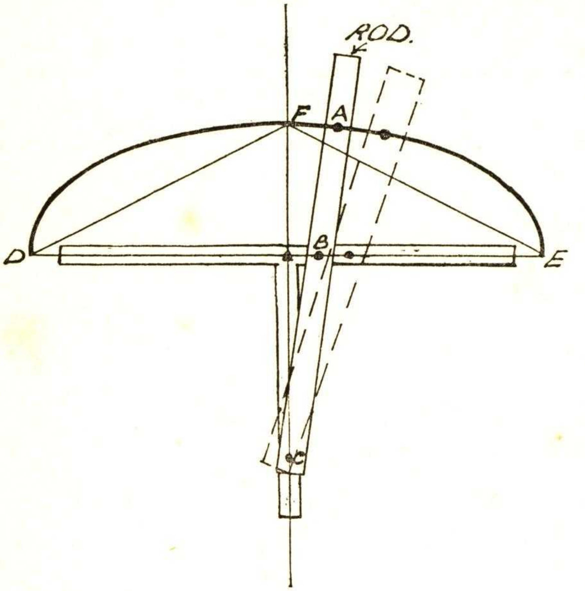


FIG. 96.

Use of the Trammel.—Fig. 96 is an illustration showing another method in forming the semi-ellipse curve by the trammel. Draw the width of the opening by forming a base line D to E. The method of striking this curve is to obtain a T-shaped piece of wood as shown. This is usually a piece of slater's batten with a deep groove formed in the centre of it. The groove should run horizontally and perpendicularly the whole length of the T piece. It should be planed up for smooth running of the trammel rod. If the openings were about 3 feet in width this T rod should be made about 3 feet long, both the horizontal and also the perpendicular ways. The trammel rod is formed with two projections on its under surface which sink into the groove of the T-shaped frame. The T piece should be placed in a position horizontally and the centre line of the groove of the top portion should be in exactly the same position as the base line DE, and the perpendicular part of the T piece should show a line, the centre of the groove to correspond with the centre vertical line of the arch. The trammel rod is shown in the illustration. A should be a hole in which the pencil can be inserted for marking the curve of the semi-ellipse. B is the point of one of the projections which fit into the groove of the T-shaped frame, which is on the under surface of the rod. C is the other projection from the rod which fits into the groove of the frame. The distance from A to B on the rod should be half the distance of the shortest diameter of the ellipse, which is equal to the rise of the arch, that is the same as the distance from the centre point to F. The distance from B to C should be half the distance of the longest diameter, which is twice as long as the distance from B to A. The dotted line as shown represents the rod in a new position, having been moved to the right. In doing so, the point B as shown moves along the groove in a horizontal direction to the right and C moves also along the groove in a vertical direction towards the centre point of the arch. A strip of cardboard can also be used for striking out the semi-ellipse with the same measurements marked on it, and moved in the same way to form the curve of the semi-ellipse.

Four-centred Arch.—Fig. 97 is an illustration of another form of arch, the four-centred. The number of striking points is only three, but the joints or lines on the face of the arch which represent the position of the voussoirs are radiated from another point in the centre of the base line. To strike out the arch, draw the horizontal base line AB and make a point on the centre of this line, which will be the centre of the opening of the arch. At point E, erect a perpendicular line from this point at right angles to the base line AB. Extend this line to F above the base line, and to point G below the base line. Measure a distance of 11 inches in a perpendicular direction from point E to H. This distance is the rise of the arch. Erect two perpendicular lines at right angles to base at D to J and C to I; connect I and J by working line. Divide DJ into three equal parts, and also C to I into three equal parts. Connect point 3 to H. Then take a distance of two-thirds of DJ and place this distance on the line 3H. This will give 3 to point M. Then connect M to D by working line. At point M draw a line extending to N, cutting through the division point of the base line to K, at which point it cuts the centre line. Bisect the line HM, the bisection line forming the line OG. G now forms the striking point for the middle portion of the arch, that is, the point G is formed by the bisection line cutting the centre line at this point. Place the compass on point G, and extend to L, and draw the intrados curve from L to M. Then again place the compass on point G, and extend to P and draw the extrados curve from P to N. This completes the middle portion. The striking point which forms the side portion on the right is formed by bisecting the line DM and the point where the bisecting line cuts the line NK is the striking point. These two striking points are enclosed by small circles Q and R. Place compass on point R and extend to M; then from M to D draw the intrados curve of the right hand side of the arch. Then

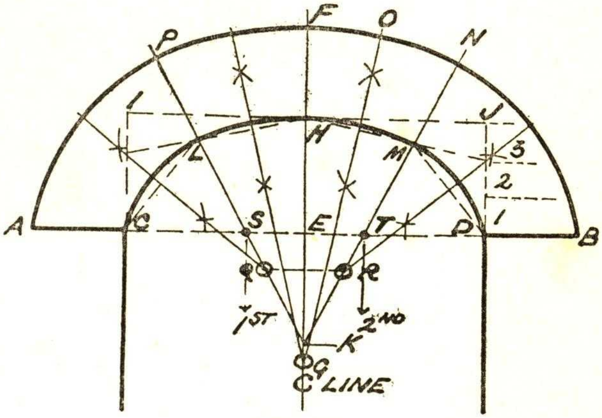


FIG. 97.

again, with compass on point R and extended to N, draw the extrados curve from N to B on the right hand side of the arch. The left hand side of the arch is formed in a similar way. The lines on the face of the arch which form the positions of the voussoirs are sometimes radiated from point E, the centre point of the base line; or they may be radiated from point G for the centre portion of the arch and from points S and T for the two side portions.

Camber Arch.—Fig. 98 is an illustration of the camber arch. For ordinary drawing purposes, it is shown with a level horizontal line forming the soffit of the arch; in actual practice, the soffit is usually cambered with a slight rise from the springing point to the centre of the soffit of the arch. The camber or rise of the soffit curve is usually one-eighth to every foot of opening. Thus, if the opening were 4 feet in width, the rise of the soffit curve would be ½ inch. Sometimes the angle which forms the skewback is taken from the base line of the arch which extends beyond the springing point, and an allowance of 1 inch per foot of opening taken along that line, and a perpendicular erected to which the angle line is formed. For instance, if the opening is 6 feet in width, the furthest point of the inclined line of the skewback would be 6 inches from the springing point in a horizontal line from the springing point. The usual method to form the skewback is to place the compass at point B and extend to point A, and draw an arc from A to D, cutting the centre line at D, then placing compass on A and extending to B, and drawing another arc from B to D, cutting the centre line at D. The position of the angle of the skewback is radiated from point D, continuing the line DB to C. The illustration also shows that this method forms an angle of 60° for the skewback. The points which form the positions of the voussoirs are divided out in the same manner as previously explained. The lines on the face of the arch, which form the positions of the voussoirs, are radiated from point D on the centre line. The depth of the face of the arch is 12 inches, the stretchers being 8 inches in length, and the half bricks being 4 inches. In actual practice the soffit of the camber is struck out by the means of using the camber slip. The camber slip consists of a long strip of wood about 9 inches longer than the opening in length, generally ½ inch in thickness and 3 inches in width at the ends, the bottom edge being straight and the top edge made with a rise

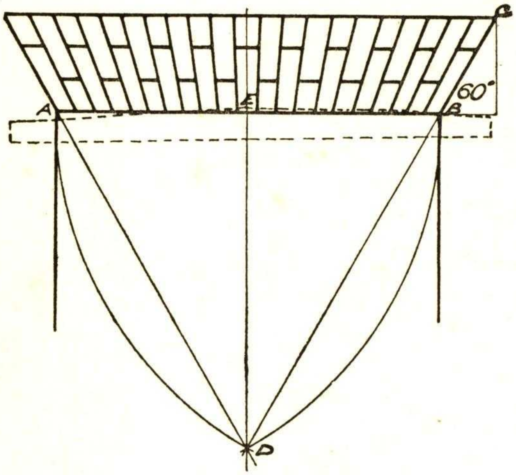
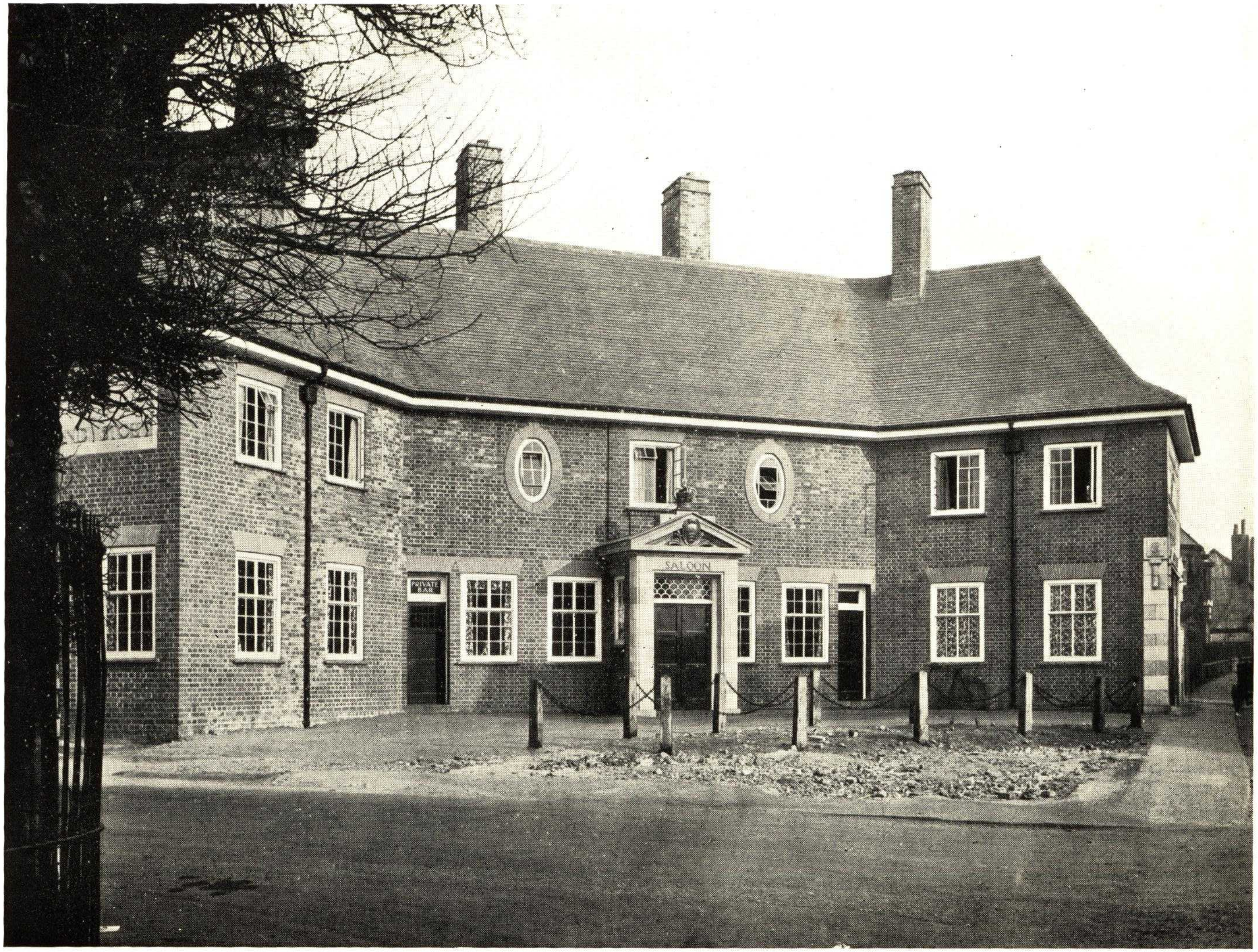


FIG. 98.



MAIN FRONT, WITH TILED ROOF, OF THE OLD CROWN, BOOKHAM, SURREY, SHOWING VARIOUS FORMS OF ARCHES.

Joseph Hill, F.R.I.B.A., M.I.Struct.E., Architect.

towards the centre point of ½ an inch. The camber slip is here seen placed in position. The base line should first be drawn from A to B and the distance of the rise marked from the centre point upwards. The highest point of the camber slip should be placed against the point of the rise, the other part of the straight edge being placed tightly against point B. Two thin round nails should be placed in points E and B, so as to enable the slip to be worked easily along. The slip should then be worked along in a direction to the right, at the same time pressing against the two nails. A pencil should also be held in position tightly against the highest point of the slip, and a mark made on the paper as the camber slip is drawn to the right. The pencil thus forms the curve of the soffit of the arch.

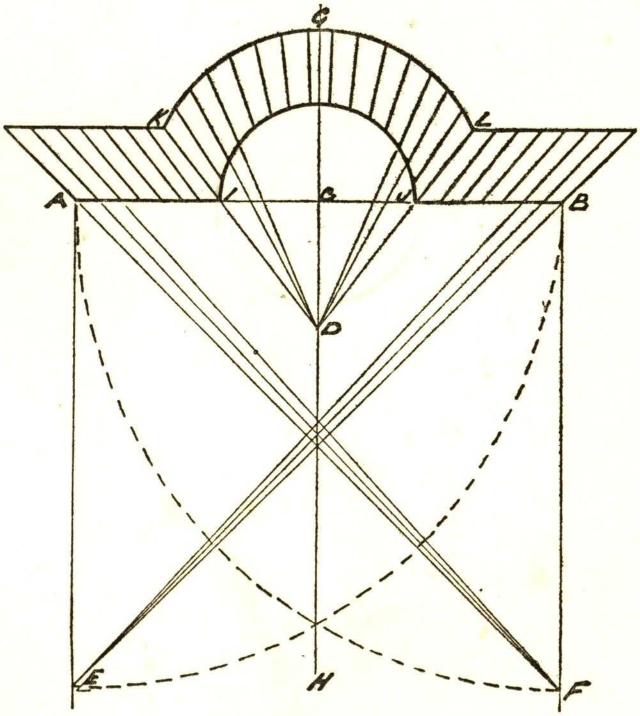


FIG. 99.

Venetian Arch or Queen Anne.—Fig. 99 is an illustration of the Venetian arch or the Queen Anne arch. The arch is composed of a centre portion of semi-circular shape, and also two end or outside portions, which take the form of the camber arch. The striking of this arch is carried out by first drawing a base line from A to B; then marking off the centre of the opening, which is point C. From this point draw a perpendicular line at right angles to the base, extend upwards to point G, and downwards to point H. Now set out the semi-circle, which is 2 feet in width, by placing the compass on point C on the base line and extending to point I. Then from point I draw a semi-circle to point J, the rise of the semi-circle being 12 inches, or half the length of the opening. This forms the soffit curve of the middle portion of the arch. The soffit of the side portions of the arch is formed by the base line A to I and J to B. The top of the side portions of the arch are formed by two straight lines at a parallel distance of 9 inches from the soffit lines. The extrados curve of the semi-circular arch is formed by placing the compass again at point C, extending the compass to point G, and striking an arc to the left and right, until it cuts the top line of the camber on each side. At points K and L, take a distance of one and a third of the rise from point C to D. The lines on the face of the semi-circle which form the positions of the voussoirs are radiated from this point at D. The lines which form the positions of the voussoirs on each face of the side portions of the arch are radiated from points E and F, point F forming the radiating lines for the left hand side, and point E forming the radiating lines for the right hand portion of the arch. These points also form the radiating lines for the angle of the skewbacks. To obtain points E and F, place the compass on point B, extend to A, and draw an arc from A to F.

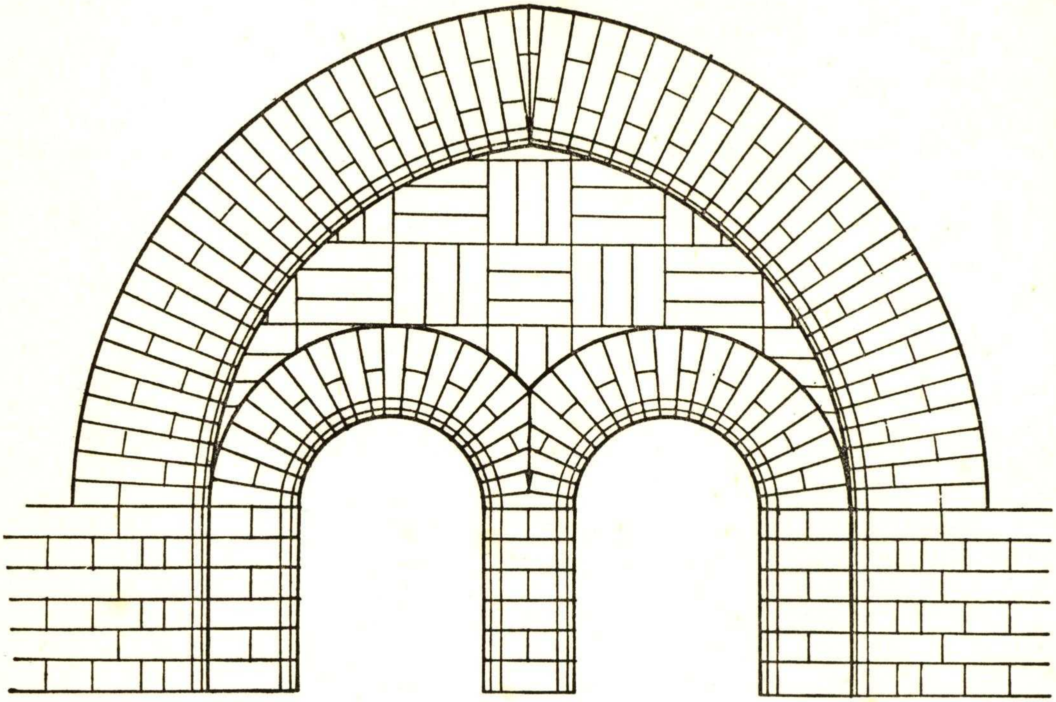


FIG. 100.

This gives the point where the arc cuts the perpendicular line at the right hand side of the opening. The point at E is obtained by the same method as F.

Moulded Arches.—Fig. 100 is an illustration of two small semi-circular arches with moulded soffits and reveals; also a larger arch in the form of a drop Gothic with a moulded soffit. The diaper bond of which it is formed is recessed back from the face of the arches for a distance of 2¼ inches. The whole can be made to look very effective if built in red rubbers, and finished with neat putty joint. The striking out of both of these forms of arches has been explained previously, as well as the method of arriving at the intersection of the semi-circular arches which are shown in the illustration.

Forming Bevels.—In order to explain the method of forming bevels, we will take as an example a semi-circular arch. Fig. 101 is an illustration of the semi-circular arch, showing the positions of the bevels which are placed against the intrados and extrados curves of the arch. The stock of the bevel should be placed against the line of the bed joint and the blade of the bevel should be placed against the intrados or extrados curve, according to which is being taken. These bevels can be taken in this way and also applied by the same method to the other arches just mentioned. In the case of the semi-circular arch, the one position of the bevel is taken, say for example, at No. 1, and this same position will answer for all the soffits of the bricks in the intrados curve. All the soffits of the semi-circular arch being the same bevel, the position of the soffit bevels can be taken on the left-hand side, and the same position can be taken for the soffit bevels on the right-hand side, with the bevel reversed. The same applies when taking the bevels for the extrados curve. Now we must obtain the shape of the template. This is usually a piece of wood exactly the same shape as the key brick of the arch, and usually about 6 inches longer than the depth of the face of the arch and $\frac{3}{8}$ inch in thickness. Great care should be taken to form this template to the exact size of the key brick. Any defect in its shape will be greatly increased when it is traversed round the face of the arch to prove its accuracy. This method of trying is called traversing. Two straight edges are also required for the purpose, as shown, and are usually 2 inches wide, 18 inches in length, and $\frac{3}{8}$ inch in thickness. The first traverse should be to obtain the exact size of all the voussoirs in the arch. This is done by placing the template in a position exactly over the key brick of the arch, and the template should be marked on the left hand edge exactly at the point of the intrados curve. Now one straight edge should be placed on the left side and one on the right side of the template. The left-hand side straight edge should be fixed so that the soffit mark on the template can be seen and kept to the soffit curve each time it is moved round. Then the traversing is commenced by removing No. 1 and 3, that is, the left straight edge and the template; 2 must remain; No. 1 must then be placed against the left side of No. 2; No. 2 must next be removed and the template placed against No. 1. This brings the template, which is marked No. 3, into a new position. Repeat this operation until the right hand side of the template finishes

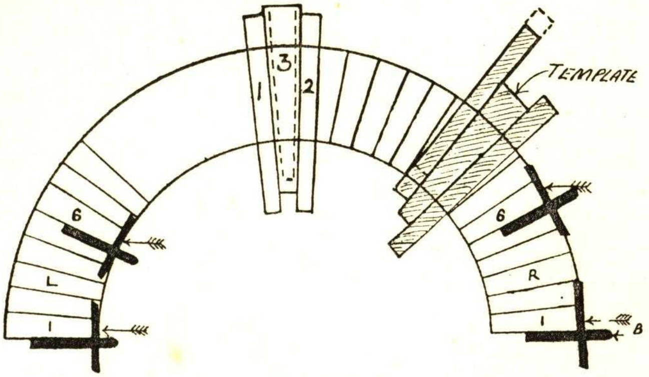


FIG. 101.

exactly with the springing line of the arch. Now another traversing is necessary for the allowance of the joints on the face of the arch. There are several methods of doing this, and one method is to place the template in the same position as before, with the intrados mark on the template in the same position. Place the two straight edges on each side as shown in the illustration; then slide the template upwards until the thickness of a joint is shown on each side of it, between the two straight edges. Then mark the soffit curve point on the side of the template. In this new position, trace round as before, and when the finished position is attained, the right hand side of the template should be in a parallel position to the springing line and a distance away from it equal to the width of all the joints on the right hand half of the arch. The new position of the template, after it has been pushed upwards, is shown in No. 3, by dotted lines. The thickness of the putty joint is usually $\frac{1}{16}$ inch. The template and two straight edges which are shown in shaded lines show the left hand side straight edge in a higher position, indicated by dotted lines above the previous position, in order that the soffit curve point can be seen on the template each time it is moved. The template being complete with cutting marks of the voussoirs upon it, is now ready to be placed in the cutting box, and the sides of the box made to correspond to its shape by adjusting the movable bottom of the box to fit it. The bevel mark can now also be placed on the template, which can be taken from the drawing. The bevel line on the template can be tested by placing the bevel at a certain angle and marking it from the side of the template; keeping the blade of the angle at the same bevel, reverse it and mark another line from the side of the template. This forms an angle; bisect this angle, and the bisection line should be the exact bevel line of the soffits of the arch, similar to the bevel line which was taken from the intrados curve of the arch. The bricks can now be placed in the box and cut to the bevel on the soffit, and the extrados line of the arch. The box in which the bevels are cut is generally the 9 inches by $4\frac{1}{2}$ inches box; the bricks are placed in this box on their edge. A straight edge can be held in position on the end of the box, just above the face of the brick. The blade of the bevel can be held against this straight edge, and the stock of the bevel along the bed edge of the brick. The straight edge can be taken away, and the side of the bevel blade marked for cutting. The bevel face will be in a line with the ends of the box. The bricks can be kept in position by tacking a small piece of lath in the bottom of the box, along the surface bed of the brick. The other end of the brick can be treated in a like manner. The brick can then be placed in the reducing box, which has been explained, and cut to the finished shape of the voussoir.

In the case of the semi-elliptical arch, two templates are required, one for the centre portion of the arch, and the other for the two side portions. The bevels are all the same for the centre portions, being an arc or part of the semi-circle. The bevels again of the two side portions are the same as each other, this also being an arc, and all the bricks practically at right angles to the normal curve. The Gothics being formed of two arcs, the same thing applies to their bevels, and the positions of the voussoirs of the arch. In the case of the camber arch, the soffit bevels are different from each other. The traversing of the template on the face of the camber can be carried out in the same way as in the semi-circular arch. The same applies to the semi-ellipse, each section of which can be traversed by the method as explained. All the soffit bevels, and also the bevels which form the top face line of the camber arch, should be taken one by one and placed on the face of the template, and marked 1, 2, 3, 4, 5, and so on left, and 1, 2, 3, 4, 5, and so on right, so that when the time comes for taking them off the template, their different positions in the voussoirs in the arch will be readily recognised.

CHAPTER X

GAUGED WORK: ARCHES (*Continued*)

Ogee Arches—Other forms of the Ogee—Arabian Arch—Three-centred Ogee Arch—Moorish Arch—Pointed Trefoil Arch—Gothic Ellipse—Tudor Arch.

In the preceding chapter, we have considered the main subject of arches as carried out in gauged brickwork. But certain minor though important details have still to be discussed. In the following pages, the less common types of arches are dealt with, and the reader is shown how to carry them out.

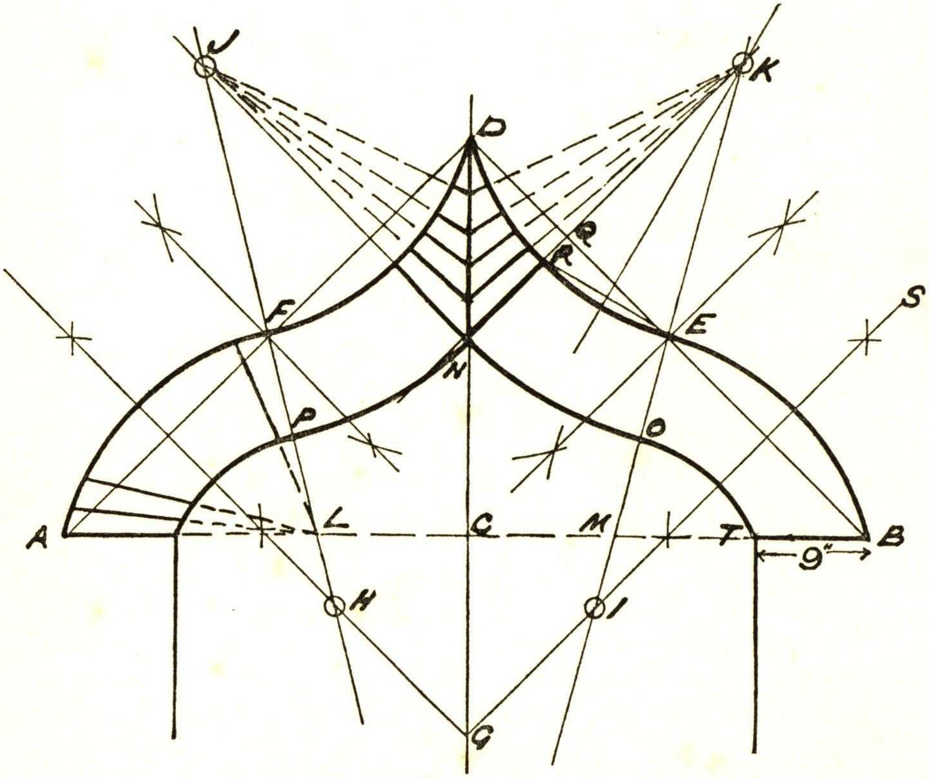


Fig. 102.

Ogee Arches.—Fig. 102 is an illustration of the Ogee arch (*Cyma Reversa*). It is composed of compound curves, two forming the intrados and two others making the extrados. These curves terminate in a sharp point at the apex, or top, that is to say, the highest point of the arch. To strike out the arch, the base line AB must first be drawn; then divide the base line into two equal parts, and define the centre point C. From C, draw a perpendicular line at right angles to the base line. Extend this line upwards to D, and in a downward direction to G. Then define the height of the arch, which is at point D. Next connect A to D and B to D. The two lines and the base line form the shape of a triangle. Now bisect the lines BD and AD. These bisection lines cut the lines AD and BD at points F and E, and if continued towards the base line, will both cut it at the centre point C. Next bisect lines EB and AF. The bisection lines of these two lines continued will cut the centre line at point G. Now bisect lines ED and FD. The bisection lines of these two lines will cut the centre line at point N.

This done, treat the curves DE and DF as you would a segmental arch, taking the line DE as the base line of the arch, and points Q to R as the rise of the arch. Bisect the line E to R, and continue the bisection line until it cuts the centre line of the arch at point K. This will give you the striking point for the curves DE and NO, which form the right hand top portion of the arch. The top and bottom portions of the arch are divided by points E and O. The left hand top portion of the arch can be formed in the same manner. To obtain the striking point at C, points K and E should be connected by a working line, and continued until it cuts the line SG, at point I. This forms the striking point for the curves at the bottom right hand side of the arch B to E and T to O. This completes the whole of the right hand side of the arch. The left hand bottom portion of the arch can be drawn by the same method. The lines on the face of the arch form the various positions of the voussoirs. The portion between A and F is radiated from point L. The portion between F and D is radiated from the striking point at J. The right hand side is treated by the same method, and forms the completion of the striking of this form of arch.

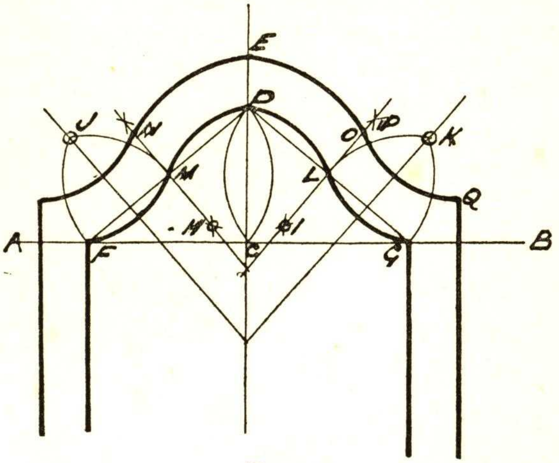


FIG. 103.

Other Forms of the Ogee.—Fig. 103 is an illustration of two more forms of the Ogee arch (*Cyma Recta*). To strike out this arch, first draw the base horizontal line A to B. Then define the centre of opening at point C. Erect a perpendicular line at right angles to base line at point C and extend upwards to E. Define points at FG, which are equal distances each side of the centre line, and form the width of the opening. Connect points FG and D by working lines. This forms a triangle, the apex of which shows the distance of the rise of the arch from point C on the base line. Now bisect the lines FD and GD. The bisection lines will cut these lines at points H and I. I forms the striking point for the intrados curve and extrados curves at the left top portion of the arch. These are marked D to H intrados curve and E to L extrados curve. The same striking point at I forms the point of radiation which forms the lines on the face of the arch representing the positions of the voussoirs. The right hand curves of the top portion of the arch are formed by the same method from point H. The lines JK form the connecting points of the compound curves of the arch. Next place the compass on point I, and with a radius equal to IG draw an arc from G until it cuts the line JK at point K. Then place the compass on point K, and with a radius equal to KG strike an arc from G to I. This forms the intrados curve of the right hand bottom portion of the arch. Again with the compass at K and extended to M, draw an arc from M to N. This forms the extrados curve to the right hand bottom position of the arch. Point K forms the radiation point and striking point to this part. Use the same method to strike the left hand bottom portion from the striking point at J. The depth of the face of the arch is 9 inches as L to H or I to M. The radiating line from point I is shown and marked thus, RL. The intrados curve marked No. 1, and the extrados curve marked No. 2, on the same line.

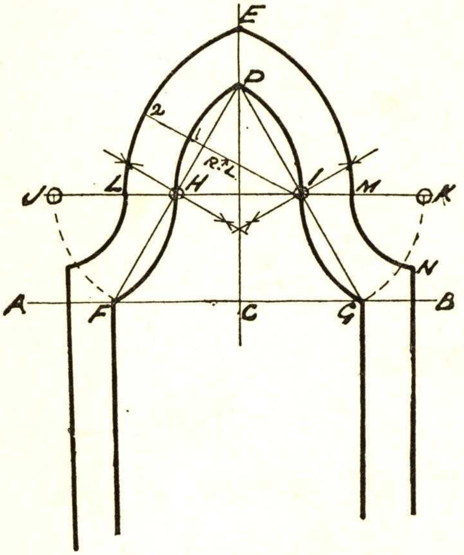


FIG. 104.

Fig. 104 is another illustration of the Ogee arch of the same form (*Cyma Recta*), but which has a much lower rise. To draw or strike out the arch, draw base line A to B. Define the opening and divide into two equal parts, which will give the centre point of the opening at C. Erect a perpendicular line at this point at right angles to the base line, and extend it a little above point E. Then measure the rise of the arch from C to D. Connect by working lines F, D, and G, forming a triangle. Bisect lines GD and FD. The bisection lines will divide the arch into two sections and at the same time form the connecting points of the compound curves at points M and L and N and O. Then, with compass on point L and radius equal to LP, mark off the striking point at I on the bisection line DG. This gives us the striking point for the curves MD and NE. The striking point for the curves EO and DL are obtained at H. This forms the top portion of the arch. The striking points for the left and right hand bottom portions of the arch are obtained by first placing the compass on point G, and with a radius equal to LG draw an arc from L to K. Then reverse compass and place on L again with radius equal to LG. Draw an arc from G to point K. This forms the striking point for the curves LG and OQ,

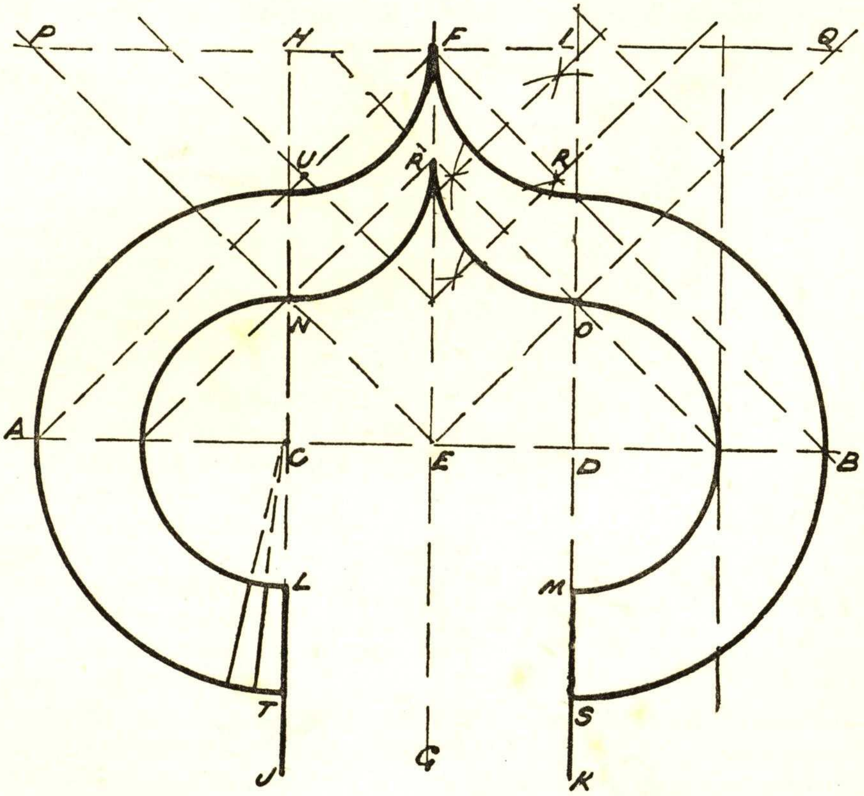


Fig. 105.

which forms the bottom right hand section of the arch; the left hand bottom section is formed in a similar way.

Arabian Arch.—Fig. 105 is an illustration of the elevation of an Arabian arch. To strike out the arch, draw the base line AB, and set out the opening CD. Then define the centre of the opening at point E; erect a perpendicular line from point E upwards to F and downwards to point G. Then at points C and D erect perpendicular lines parallel to line FG. These lines should extend to points H and I at the top, and points J and K at the bottom. Now at points C and D, with radii equal to DO and CN, draw two semi-circles from O to M on the right hand side, and L to M on the left hand side. Then with compass on D, extended to B, draw the outer semi-circle on the right hand side of the arch from point R to S. The left hand side semi-circle on the extrados curve is drawn by placing the compass on point C, extending to A and drawing the left hand outer semi-circle T to U. The division line of the two left hand semi-circles is formed on the line HJ. The two on the right are formed on the line IK. Draw a horizontal line level with point F from P to Q. Bisect lines FA and FB, which will give points N and O. The striking point for the extrados curve F to R on the right hand side of the arch is obtained by bisecting the line FR and continuing it until it strikes the horizontal line PQ at I. I is the striking point. The striking point for the intrados curve RO at the right hand side of the arch is obtained by bisecting the working line RO and continuing it until it cuts the line FB at R. R is the striking point. The striking points at the left hand side of the arch are obtained by the same method. The lines which form the positions of the voussoirs on the face of the left hand bottom side of the arch are radiated from point C, and on the right bottom side from point D, in the same manner as the semi-circle. The top left and right hand portions, the lines on the face of which represent the positions of the voussoirs are radiated from point H for the left hand side, and point I for the right hand side.

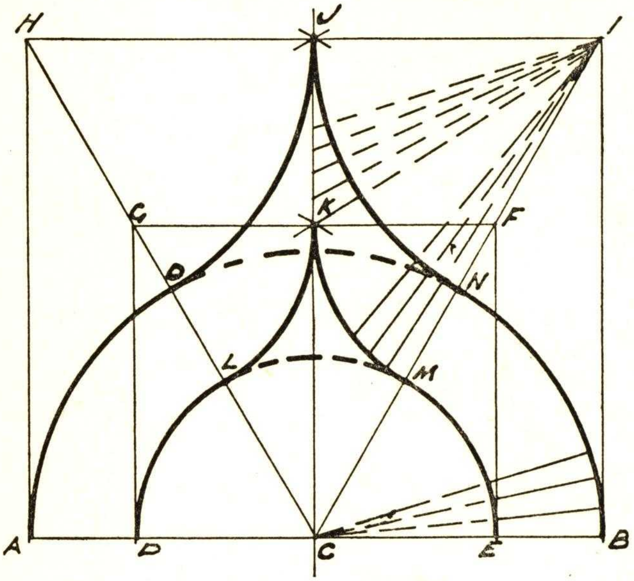


FIG. 106.

Three-centred Ogee Arch.—Fig. 106 is an illustration of another form of the Ogee arch (*Cyma Reversa*), three-centred. To strike out this arch, draw the base line AB. Set out the opening which is 2 feet 6 inches in width, and also set out the width of the face of the arch an extra 9 inches on each side of the opening. The centre point of the opening on the base line is point C. The points at each side of the opening are D and E, which are the springing points of the arch. Erect a perpendicular line at right angles to the base line in the centre of the opening at point C, and extend to point J, which is a distance of 3 feet 7½ inches from the base line. This forms the highest point of the outside curve of the arch. Then again, at point C, take a distance upwards of 2 feet 3 inches. This forms the highest point of the inside curve of the arch. Then at point D erect perpendicular to G equal to the distance CK. Again at E, erect another perpendicular to F, again equal to CK. Connect G and F by a working line. Then with compass point at C, and extended to D, draw the intrados curve D to L. Then again with compass point at C, extend to A and draw curve from A to D. The right hand bottom portion can be drawn from the same point at C, that is, E to M and B to N. Then place the compass on point G and extend to L, and draw the arc from L to K. Then again, place the compass on point F, extend to M and draw the arc from M to K. Now erect two perpendicular lines at right angles to the base line from A to H and B to I, making them both equal to CJ. Then with compass on H, extended to D, draw the arc from D to J. Again, with compass on point I, and extended to N, draw an arc from N to J. The radiation of the lines, which form the position of the voussoirs on the face of the arch, are radiated from three points, two points for the top portion at H and I, and one point for the bottom portion at point C. The top and bottom portions of the arch are divided by the lines CH and CI.

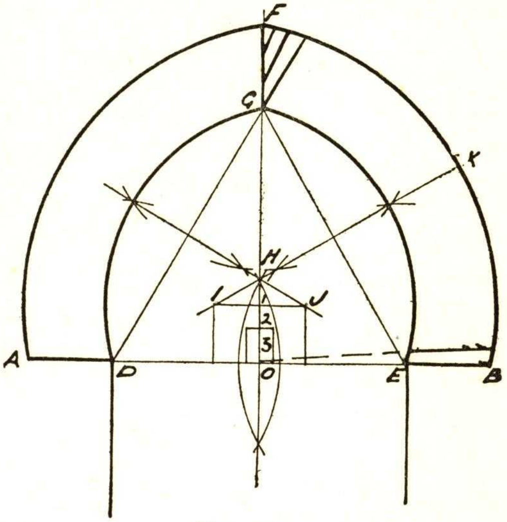


FIG. 107.

Moorish Arch.—Fig. 107 is an illustration of the Moorish arch. The striking out consists of drawing the base line AB, and marking off the size of the opening along this line, which is 2 feet 6 inches in width. Also mark another extra 9 inches beyond this length at each side of the opening. This is the width of the face of the arch. Mark the centre of the opening at point C. From point C erect a perpendicular line at right angles to base line and extend upwards to point F. Then again, from point C, take a distance upwards of 2 feet $1\frac{1}{2}$ inches, which forms the rise of the arch at point G. Connect DG and EG together by working lines, which form a triangle with the inclusion of the base line. Then bisect lines DG and EG. These two bisection lines will cut the centre line at point H. These two lines should be continued further, so as to obtain the striking points I and J. To obtain these striking points, divide CH into three equal parts. Then take the bottom point No. 1 of the top equal part, and draw a horizontal line until it cuts the bisection lines DG and EG at the points I and J, which form the striking points. Point I forms the striking point for the intrados curve GE with a radius equal to IG and also the extrados curve FB, with a radius equal to IF. This forms the two curves for the right hand side of the arch. The lines which form the position of the voussoirs on the face of the right hand side of the arch are radiated from two points. The top portion from F to K is radiated from point D, and the bottom portion from B to K is radiated from point C, on the centre of the base line. The left hand portion of the arch is struck out and radiated from points J and C and E.

Pointed Trefoil Arch.—Fig. 108 is an illustration of the pointed trefoil arch. The striking out consists of drawing the base line AB, and finding the centre of opening at point C. Erect a perpendicular line at this point, at right angles to the base line AB. Then set out the opening FG. Next, from the centre of the opening at point C, take a distance in a perpendicular direction to point E. This forms the rise of the arch. Then connect by working lines points F, E, and G. These three points form a triangle. The opening in this case is the width of the base line, which is 2 feet 6 inches in width, and the rise of the arch from point C to E is 2 feet in height from the base line. Divide the perpendicular line CE into two equal parts, which gives us point J. Draw a horizontal line through this point to H, and I. Bisect the lines IG and FH, then draw bisection lines MQ and NR, Q and R being the points where these bisection lines cut the base line. At the last-mentioned points, Q and R, divide the line JE into two equal parts, and draw a horizontal line to points K and L. Then bisect lines HE and EI, and draw the bisection lines till they cut the horizontal line KL at points O and P. Then, with compass at point R, on the base line AB, extended to I, draw an arc from I to G. Then again, with compass at point R, extend this time to point L, and draw an arc from L to B. The striking point at R on the base line thus forms the bottom right hand portion of the arch. The lines on the face of the arch, which represent the positions of the voussoirs for this portion of the arch, are also radiated from point R on the base line. The left hand bottom portion is treated in the same way from point Q on the base line. The top right hand portion of the arch is formed by placing the compass on point O, which is on the line HI, and extending them to E and drawing an arc from E to I, and then again placing the compass on point O, extending it to D and drawing an arc from D to L. The point from which the lines on the face of the

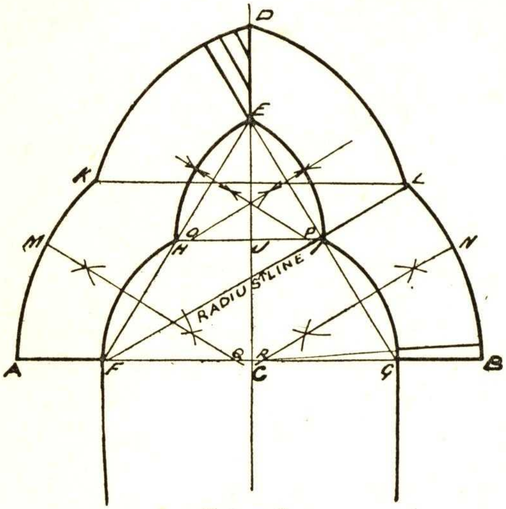


FIG. 108.

arch, which represent the voussoirs, is taken from point F on the base line for the right hand top portion of the arch, and from point G for the left hand portion of the arch. This completes the setting out of the arch. The templates for taking the soffit bevels of the voussoirs are taken in a similar manner to that of the segmental arch. The centre vertical joint of the arch is similar to that of the Gothic.

Gothic Ellipse.—Fig. 109 is an illustration showing a method of setting out the Gothic ellipse, of which several will be explained. Draw the

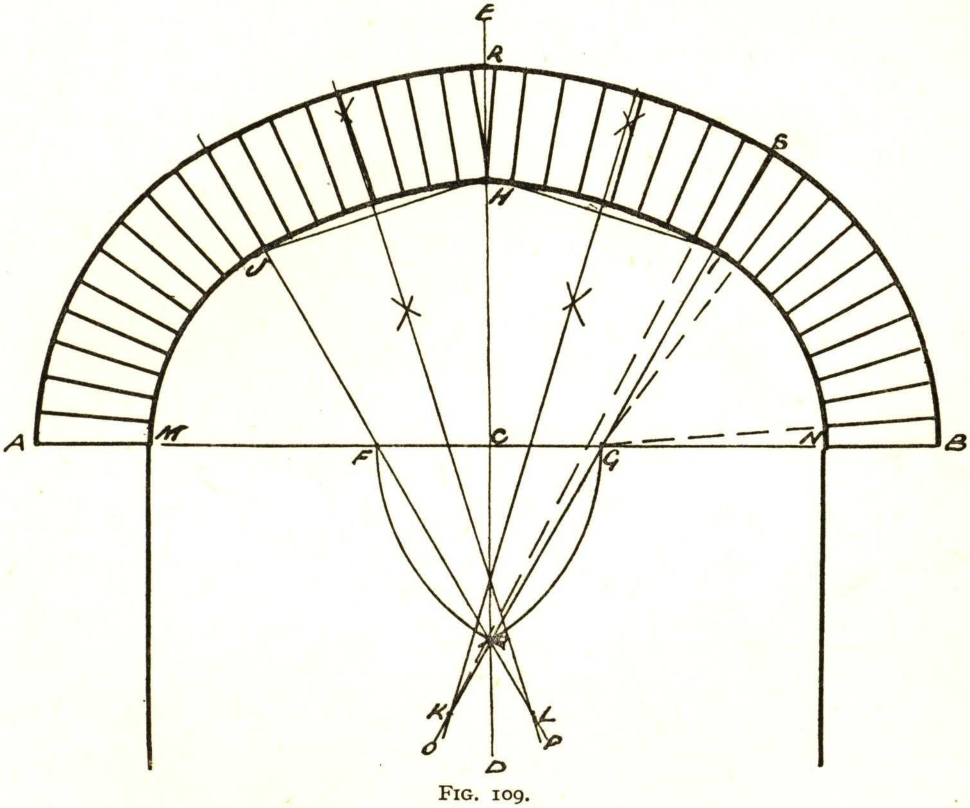


FIG. 109.

base line AB; set out the opening MN, which is 4 feet 6 inches wide; erect a perpendicular from point C at right angles to the base line. This is the centre of the opening. Extend the perpendicular centre line to E and D. Divide the base line of the opening MN into three equal parts. Then, with compass on point G extended to F, draw an arc from F to Q. This is the point where the arc cuts the centre line. Then again, with compass on point F, and extended to G, draw another arc from G to Q, which will strike the same point on the centre line as the arc FQ. Draw a working line from O to I, passing through the points Q and G. Then again, draw another line P to J, passing through the points Q and F. Now with compass on point G extended to N, mark a point equal to radius of GN at I. Then mark J on the left side of the arch by the same method, and measure the rise of the arch, which is 1 foot 9 inches in this case, from point C to H. Connect by working lines JH and IH. Bisect the line HI on the right hand side of arch. Continue bisection line until it cuts the line IO at point K. Repeat this for obtaining the point L. Point K forms the striking points for the right hand top portion of the arc. Place the compass on point K, extend to H and draw arc from point H to I. Again place the compass on point K, extend to R, and draw an arc from R to S. The lines on the face of the arch, which represent the positions of the voussoirs, are radiated from this point at K for the top right hand portion of the arch. The left hand top portion is obtained in a similar way from point L. The striking and also the radiating points for the lines, which represent the voussoirs of the left and right hand bottom portions of the arch, are at points F and G on the base line AB.

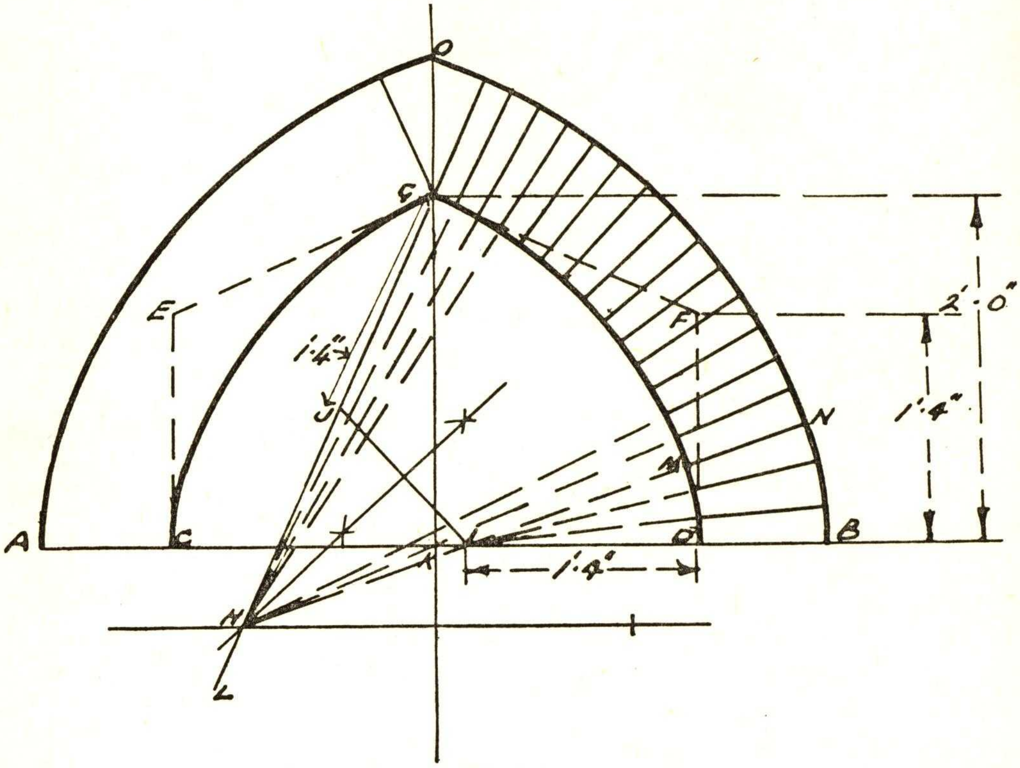


FIG. 110.

Fig. 110 is an illustration showing another method of striking the Gothic ellipse. Draw the base line AB. Define the width of the opening CD, which in this case is 3 feet in width. Divide the opening into two equal parts, which gives the point K. Erect a perpendicular line at point K at right angles to the base line. Set out the rise of the arch, which is 2 feet in height. Erect two perpendicular lines on the base line equal in length to two-thirds of the height of the rise. This gives us the lines C to E and D to F. Then connect E to G and F to G. Now take a distance of two-thirds of the rise, which is 1 foot 4 inches along the base line from D to I. Then draw a line at right angles to line GF from

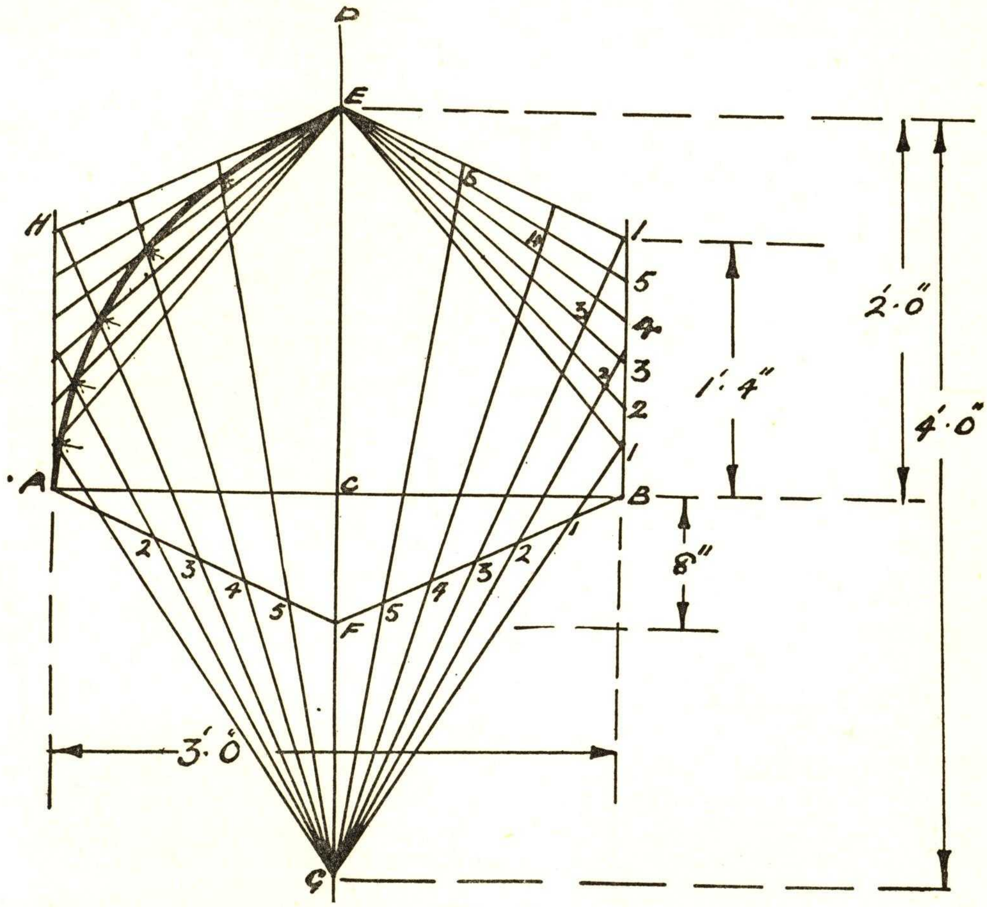


FIG. 111.

point G to L. Take a distance of two-thirds of the rise and place it along this line from G, which gives the point J. Connect J and I. Bisect the line JI and extend it until it cuts the line GL at point H. Place the compass on point H, extend to G and draw an arc from G to M. Then again with the compass on point H extended to O, draw an arc from O to N. The face lines which form the voussoirs positions are also radiated from this point for the higher section of the right hand side of the arch. The left hand side is done in a similar way. Then place compass on point I on the base line AB and extend to M, and draw an arc from M to D, and again on point I extended to N, draw an arc from N to B. This completes the right hand lower portion. The left is done in a similar manner. The lines which represent the positions of the voussoirs are also radiated from point I for this portion of the arch.

Fig. 111 shows how to draw a Gothic Ellipse to any given height and span. Set out the base line AB representing the width of the opening, which is 3 feet. Find the centre point of the base line, and erect a perpendicular line at right angles to it at C. Extend upwards to D and downwards to G. Define the height of the rise, which is 2 feet, at point E. Then erect two perpendicular lines at right angles to the base line at A and B. Extend them in a vertical direction, equal to two-thirds of the height of the rise. This gives us the points H and I, which equals 1 foot 4 inches. Connect H to E and I to E. Now define point F by taking a distance from C, which is equal to one-third of the height of the rise. Then connect by working lines FA and FB. Next define point G by taking the distance of the height of the rise downwards from point C on the base line. Now divide AH and BI each into six equal parts as shown marked on the right hand side B to I and numbered 1, 2, 3, 4, 5, these being the division points of the six equal distances. Next divide the lines AF and BF into six equal parts. The division points are marked on these two lines. Now draw line for example from G through point I on the line FB until it cuts with point I on the line BI. All the other lines will follow in the same manner. Now connect points 1, 2, 3, 4, 5, on the line BI with point E. For instance, where the line GI cuts the line EI, it forms the first point of the curve from the point B to I. Again where the line G2 cuts the line E2. It thus forms the part of the curve from 1 to 2 on line E2. The curve is drawn and shown on the left hand side of diagram, the arrows indicating the various points through which the curve passes.

Tudor Arch.—Fig. 112.—This illustration shows a method of striking out the Tudor arch. Draw the base line AB ; find the centre of opening at point C. Erect a perpendicular line from this point at right angles to the base line. Extend upwards to D and downwards to point E. The width of the opening is 3 feet 6 inches. The rise in this case is 11 inches, but no stated rise need be given in striking out this form of arch in this particular case. In this example, a point at J is taken. Connect I to J and H to J. Bisect these two lines, which give the bisection lines KF and LG. These, as will be seen, are taken to a point at the sides of the opening. Now take distances from H and I towards point C on the base line, making them both equal. This gives us points M and N. These points can be continued down to F and G. Points F and G are the striking points for the top portion of the arch. Then with compass at point G, and extended to Q, draw an arc from Q to S. Then again with compass on G and further extended to O, draw an arc from O to D. These two arcs form the intrados and extrados curves to the upper portion of the left hand side of the arch. The right hand side is formed in a similar way. Then with compass at point M, and extended to I, draw an arc from I to Q. This completes the intrados of the left hand side of the arch. Then again with compass at M extended to A, draw an arc from A to O. This completes the extrados of the left hand side of the arch. The right hand striking point for the lower

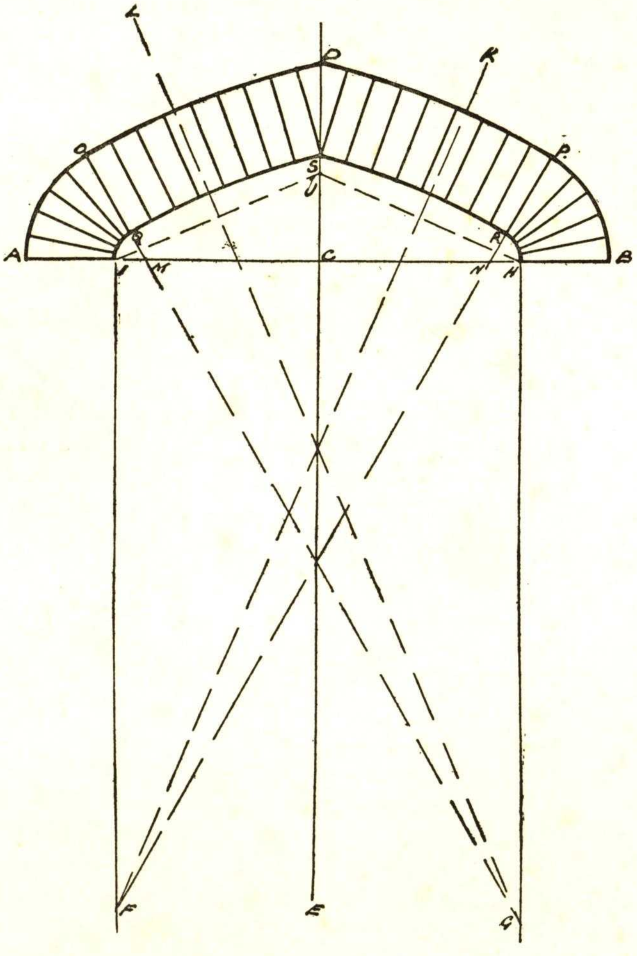


FIG. 112.

portion of the arch is at point N on the base line AB. The radiating point for the top portion of the arch, for the lines which denote the positions of the voussoirs, are from points F and G, and for the lower left and right portions from M and N. The vertical joint in the centre of the arch is similarly formed as in the various forms of the Gothics. This arch requires two templates for cutting the bricks, as in the semi-elliptical forms of arches.

CHAPTER XI

GAUGED WORK: NICHES, PANELS AND MOULDINGS

Niches—Niche Moulds—Varieties of Niches—Domes—Panels—Oriel Windows—Moulding for Cut and Rubbed Work.

GAUGED work is essentially the decorative treatment of bricks, and although perhaps more extensively used in the erection of arches of every kind, it is also constantly called into requisition for a great variety of other purposes, such as the dressing of window and doorway openings, the ornamentation of string courses and friezes, and the construction of niches and panels, sunk or raised, with their mouldings. All this work requires great care all along the line, from the cutting and rubbing of bricks, their laying in position, and the setting out of the work—especially the setting out of the work—which is here as important as it is in the setting out of arches. It is necessary to lay stress on these points which are dealt with at length in the following pages.

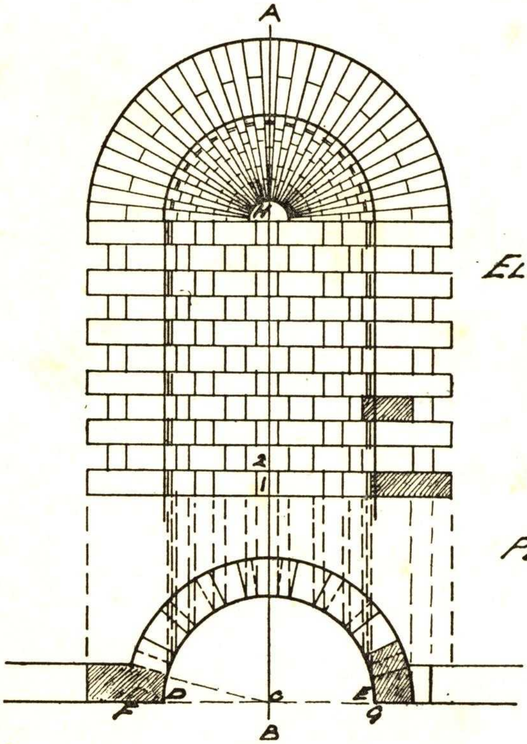
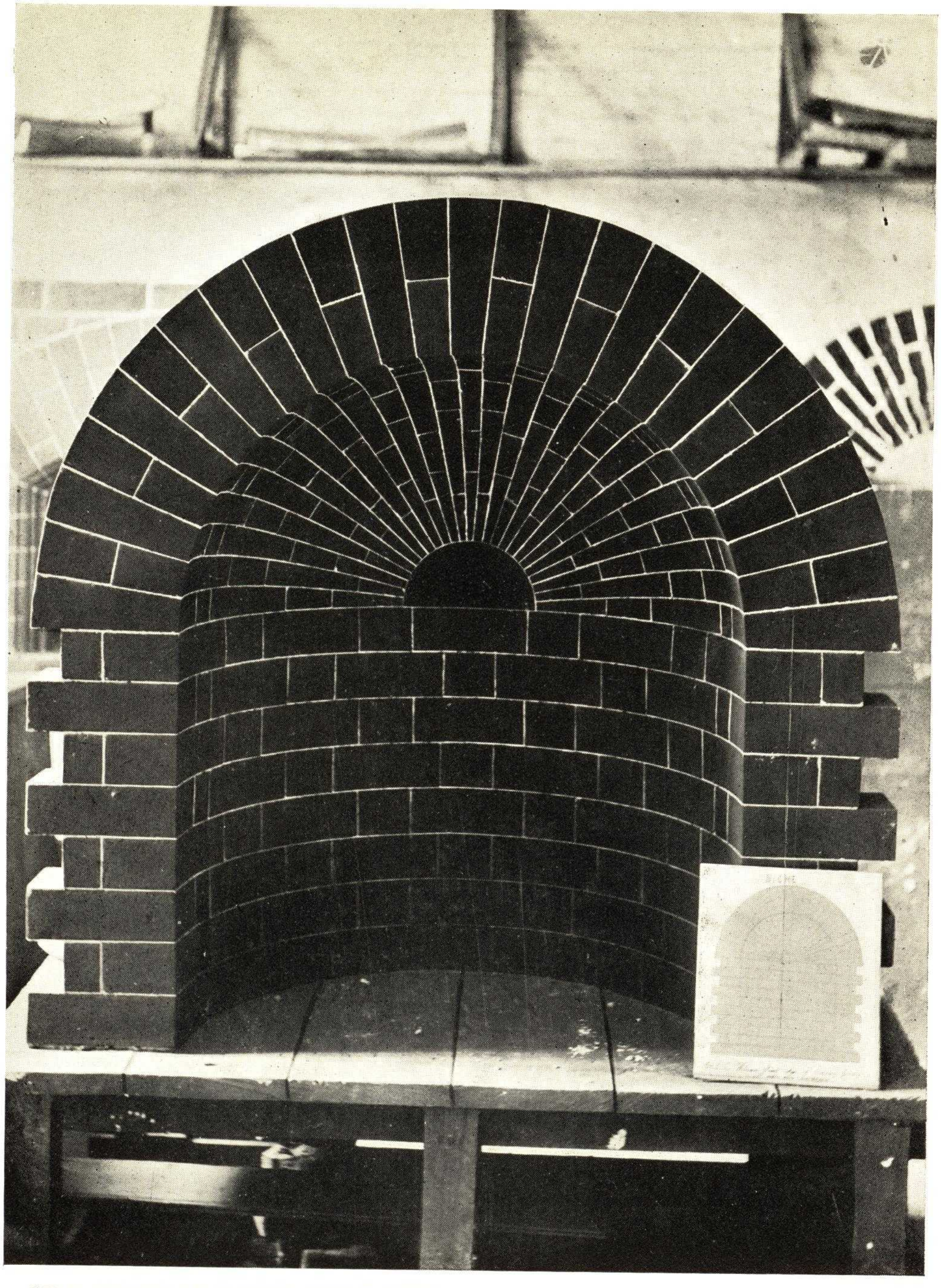


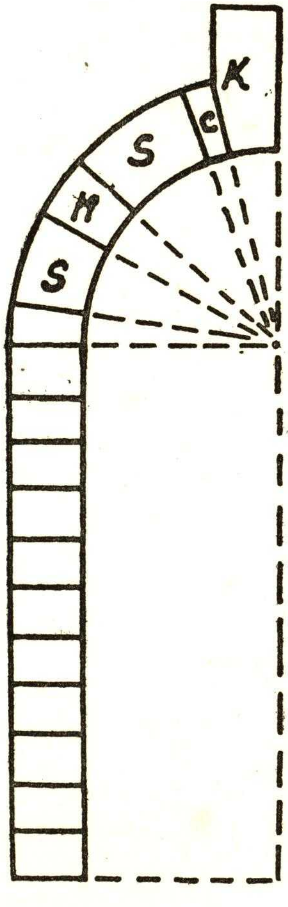
FIG. 113.

Niches.—Fig. 113 is an illustration of the plan and elevation of a niche, semi-circular in plan and elevation. The elevation and plan, as will be seen, are drawn in a method similar to that used in the semi-circular arch. The niche is divided into two parts. The body or bottom portion of the niche is formed by a circular recessed wall built back from the face of another



SEMI-CIRCULAR NICHE, BUILT WITH RED RUBBERS AND SET IN LIME-PUTTY.
Executed by the Author.

wall, which is usually built in gauged brickwork of 4½ inches in thickness. The head or top portion, or as it is sometimes called, the hood, which covers over the circular recessed portion of the body, is built in the shape of half a dome. (If a dome were cut sectionally in half, and the cut surface of one of the halves was placed in a face line of a wall, and the circular base was recessed from it, this would represent the head of a niche in the same position.)



SECTION OF NICHE

FIG. 114.

The plan is first drawn by marking out the opening of the niche, which in this case is 2 feet in width, and defining the centre point in the base line at C. Then from this point strike semi-circle from D to E, which forms the circular recessed surface for the plan of the niche, the width of thickness of the gauge work being 4½ inches. Draw another semi-circle from F to G. Next set out the bond, which is Flemish, round this semi-circle. The first course of bricks is here seen set out in plain lines, as on the right hand side starting with a stretcher in shaded lines from the base line inwards, and finishing with a centre stretcher in the centre of the recess. The left hand side shows the next course starting with a header in the recess from the base line. Next to it is the closer; then a stretcher and so on, until it finishes in the centre of the recess, with a header over the centre stretcher in the preceding course. This course is shown by dotted lines. On the left it will be noticed the shaded return brick shows a stretcher on the face of the wall, and a header on the return. On the right hand side it shows the reverse. An allowance must be made for the recessed curved bricks, being longer on the extrados, and shorter on the intrados, on account of the shape of the bricks, which all radiate from the centre point at C. Therefore, when setting out the bricks on the recessed face, this extra length which is required on the back of the bricks must be considered.

Having set out the bond on the plan, the next proceeding is to draw the elevation which is seen here. This is drawn by a development of the vertical lines from the plan. The width of the opening is projected upwards from points D and E. The first course in the elevation is projected up from the dotted course on the plan. The second course in the elevation is projected up from the plain line course on the plan, showing a stretcher in the centre of the recess, marked 2. The other centre brick in the preceding course is marked 1. The hood on the top portion of the niche is drawn as the semi-circle having a semi-circular 9 inches in depth on the face of it. The semi-circular portion in the centre of the base of the hood is called the boss, and is marked H. The centre of all the hood courses, as shown, radiates to the face of the niche. The courses are first set out on the extrados curve of the semi-circular arch, and then radiated to the centre point of H, which is the centre of the boss. The vertical joints in the recessed curve face of the niche are continued and carried round in semicircles on the soffit of the hood, these joints forming the cross joint for the hood courses.

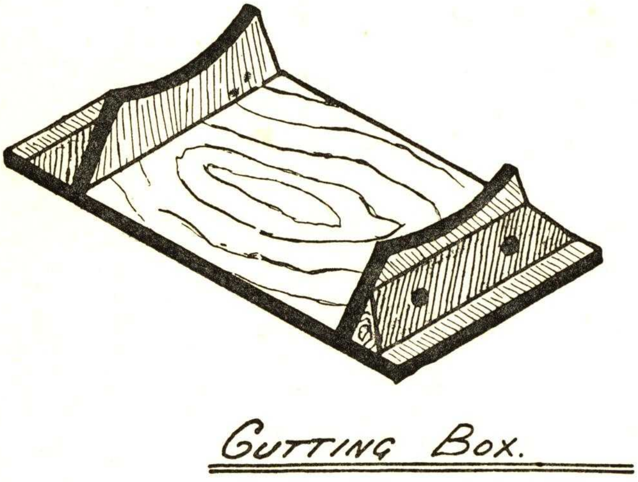

Cutting Box.

FIG. 115.

The first operation in forming the body of the niche is to reduce the bricks to a certain thickness of the courses required. These bricks can all be cut to a certain course size, say 2½ inches or 2¾ inches, or sometimes 3 inches, which will be the thickness of the courses forming the body of the niche. These can be cut in the box after this has been completed. The bricks will have to be cut to a circular-shaped face. Stretchers, headers, and closers will be required, also return headers and stretchers.

Fig. 115 is an illustration of one of the cutting boxes required to cut these special-shaped bricks. This box is used for cutting the stretchers of parallel thickness, to form the body of the niche. The special V-shaped templates which form the ends of this box are taken from the plan when the first course has been marked out. A piece of stiff cardboard will serve the purpose. This is placed over the drawing, and marked, and then cut to the required shape by the aid of a sharp knife, and a wood template, cut to the exact shape of the cardboard pattern, can then be made and fixed to the ends of a box in readiness for cutting the bricks. Patterns of the stretchers, headers, and half bricks must all be taken, and templates made and fixed to boxes for cutting these bricks. The shaded portions on the plan show two of the shapes, for which the templates have to be made.

After the bricks have been cut for the body of the niche, they are generally set to a circular mould, placed in position for the first course to be laid against. When the body of the niche has been built to the required height, a mould has to be placed in position to build the hood upon, level horizontally with the springing of the hood.

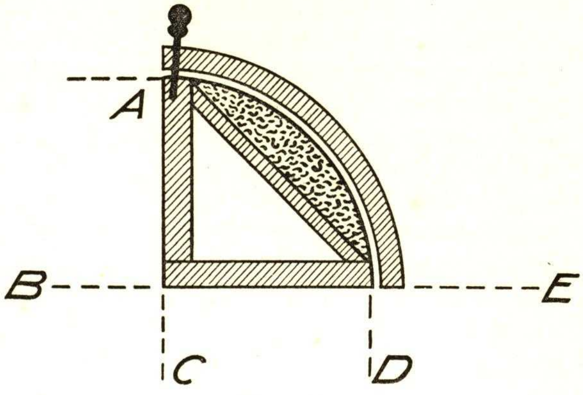


FIG. 116.

Niche Moulds.—Fig. 116 is an illustration of a section of the niche mould. (The formation of the hood of the niche is the most important part of the work.) The niche mould is formed of wood about 2 inches in thickness, generally of two ribs. The base horizontal rib should be the exact size of the niche recess, that is, 2 feet across the front face line, as shown in illustration, Fig. 118, and forming the semi-circle with a radius of 12 inches horizontally back from face line. The horizontal dotted line in Fig. 118 shows the back line of the vertical rib. The exact position of the vertical rib is shown by shaded lines. This is fixed on to the horizontal rib securely. The vertical face rib is shown (Fig. 119), but is 2 inches shorter at the base line than Fig. 118. This allows for the 2 inches thickness of wood on the horizontal base rib. Intermediate struts are then placed in positions from the marks as shown on the horizontal rib to the back of the vertical rib, the position of which is also marked. Referring back to Fig. 116, it will be seen that these two ribs are in position as well as the back struts. This then forms a semi-circle on the base, and also a semi-circle on the face. In Fig. 116, the distance from A to B is equal to the distance C to D. BE forms the base line of the niche hood, therefore the two semi-circles

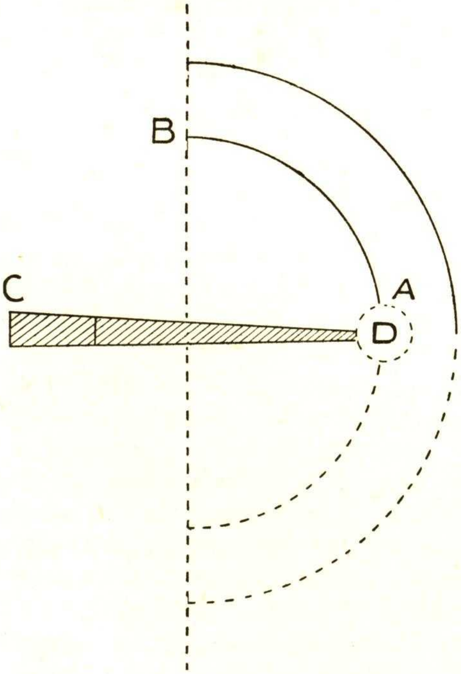


FIG. 117.

are equal. The half dome surface of the mould has now to be shaped. This forms the soffit of the niche hood. This is done by making a template, the under side of which forms a semi-circle, from A to base line E, as shown in Fig. 116. Wire is usually fixed on the upper surface of the back struts, and the template then finished in plaster. The surface must be made true to shape by the template being revolved backwards and forwards round the base line of the semi-circle of the hood mould, the top of the template at A being held in position by a long French nail or bradawl, which enables the template to work round easily. When the plaster surface is finished, this nail is taken away. The next proceeding is to draw an ordinary semi-circular arch, which forms the front arch of the niche. Having done this, the soffit marks, which form the voussoirs in the semi-circular arch, should be marked on the top of the niche mould. The mark lines from these points are carried to the centre point of the boss at the back of the semi-circular base of the hood. This is done with a lath or a piece of zinc, which will bend easily to the soffit curve of the hood. It is almost impossible in practice to form bricks to so sharp a point, therefore the boss is introduced, which gives us a greater thickness at the terminating points of the bricks at the boss. The boss can be formed easily by the aid of a pair of compasses out of one brick as a rule. It is, of course, semi-circular in elevation and section. The next thing to do is to obtain the template for cutting the courses of the hood.

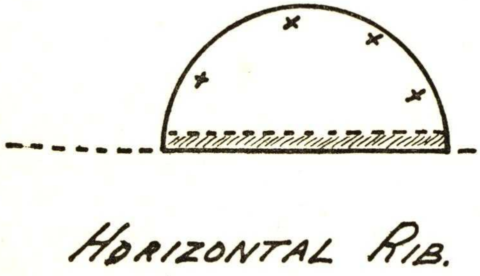


FIG. 118.

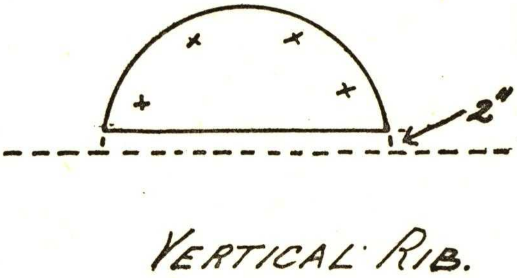


FIG. 119.

The template is shown (in Fig. 116) extending from the curve of the boss to the outside of the arch on the face line. The length of the template equals the distance as shown from A to B. This measurement is obtained by taking the distance of the curve in very small parts, and applying the same number of parts along the centre line of the template from D to C. To obtain the cutting mould, hold a piece of tracing linen over the centre course of the mould, and trace the outline. Try one or two courses for accuracy. Or these courses can be drawn in the semi-circle and traced round with the straight edge or traversed by the ordinary method, and allowance made for joints. Having secured the pattern of this template, the template can be made to the proper length. Now obtain a piece of wood 3 or 4 inches in thickness, and of sufficient length, and shape it to the curve of the intrados soffit, and length from boss to face of arch. Lay this on the bench, and paste the tracing linen pattern of template on its soffit curved surface. The piece of wood can then be placed or cut to the tracing linen pattern. When this is done, we have a template giving us the soffit curve of the hood, and also the thickness of the courses from the boss to the face of the arch. The bond which forms the hood can be traced by pencil marks round the convex curve of the template. This soffit mould is now ready for the box.

The soffit mould is shown in Fig. 120 placed in position in the box, and indicated by an arrow. The soffits of the course of bricks are placed against the convex curve of the soffit mould to the marked positions on it. Another mould can be made to the same curve as the soffit mould, but this should be the thickness of the extrados width of the hood courses, and 3 or 4 inches longer in length, as this has to cover a longer curved surface face than the soffit mould. As will be seen in plan, the width of the central stretcher is wider on the extrados curve than it is on the intrados curve in the body of the niche. The same thing occurs in the hood of the niche. The width of the intrados surface of the bricks is much smaller than the extrados surface in each course, as they diminish from the face of the arch towards the boss at the base of the hood. The extrados mould is also shown in position in the box in Fig. 120.

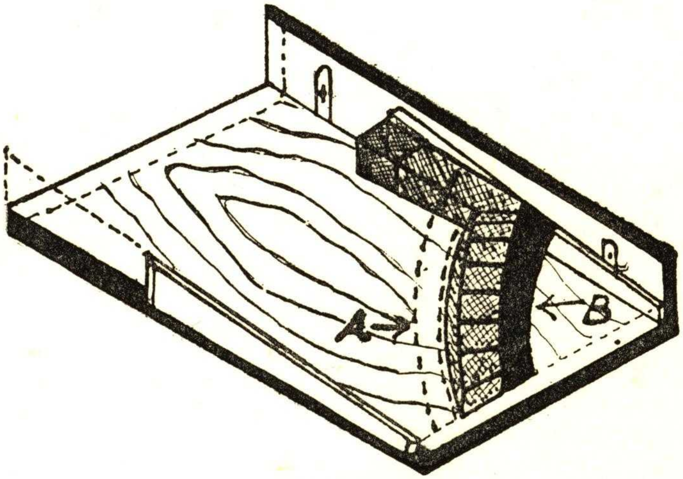


FIG. 120.

Illustrations of these moulds are also given in Figs. 121 and 122. Fig. 121 shows a soffit mould which has been cut to the soffit curve, but has not been reduced to the width of the soffit bricks in the soffit course from the face to the boss. Fig. 122A shows the finished soffit mould made to the soffit curve, and also reduced to the soffit course template, as previously explained. Fig. 122B is the extrados mould shaped to the extrados curve, which, it will be seen, is longer than the intrados curve at A. This is also reduced to the width of the extrados courses of the hood. Position in box is shown at A indicated by an arrow point in Fig. 120. The parallel distance between the soffit curve of mould B and the extrados curve of mould A should equal the thickness of the niche hood. After all the bricks have been shaped to the soffit curve of the hood, as cut in the box, Fig. 120, they should be bevelled from the soffit, that is to say, the bevel should be held with the stock touching the soffit face, and the blade forming the bevel touching the bed. The bricks can be rubbed down on the bed to obtain this bevelled surface from the soffit. This is the method sometimes used and called bevelling the bricks from the soffit. By this means, the soffits of the hood have the same bevel as obtained in the semi-circular arch. The method of taking this bevel has been explained previously. The bricks can now be placed between the two moulds A and B in Fig. 116, and the sides of the box adjusted to these mould positions. The bevelled surface of the bricks should be placed downwards. The semi-circles which form the face of the niche can be cut and set at the same time as the body and hood of the niche.

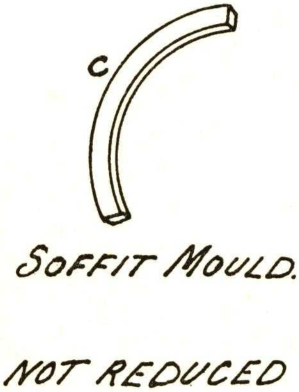


FIG. 121.

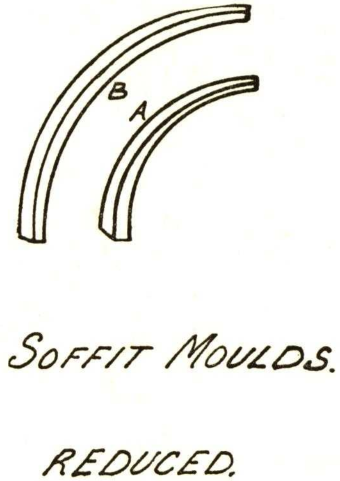
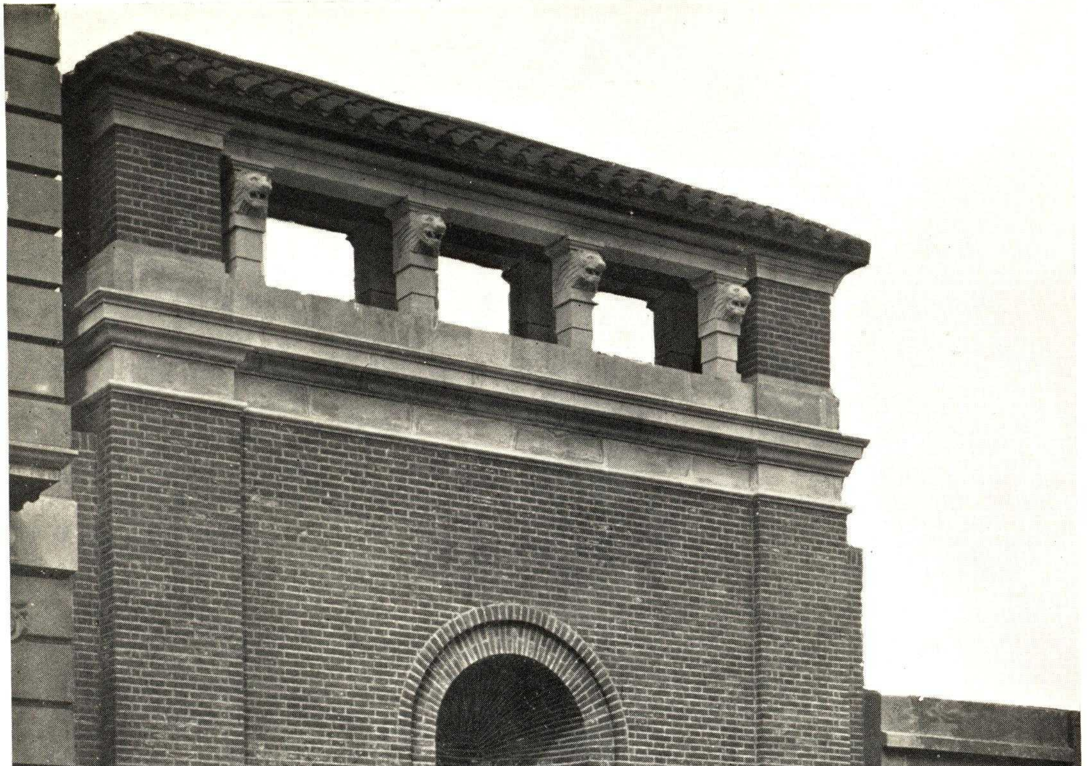


FIG. 122.

Varieties of Niches.—There are other forms of the elliptical niche, and also the segmental niche. In the case of the semi-ellipse hood, the centre or mould is made differently, being made to the elliptical plan and elliptical elevation.

Fig. 123 shows the elevation of the semi-elliptical niche. The plan should first be drawn as in the case of the semi-circular niche, and the elevation of the cross joints in the body of the niche can be developed by vertical lines from the semi-elliptical plan. Two template moulds will be required to form the semi-ellipse shape of the body of the niche, which form the ends of the cutting boxes, as in the case of the semi-ellipse arch, where two templates are required for the arch. The same will be required for the 9 inches face arch, which is also a semi-ellipse in shape. The courses which form the hood of the niche can be marked out in the same manner as in the semi-circular niche, and all lines radiate from the face of the arch to the box at the base. In this case, the boss



SCREEN WALL WITH STONE DRESSINGS, AND NICHE, CARLOS PLACE, LONDON, W.

E. Vincent Harris, F.R.I.B.A., Architect.

is formed much larger, in the shape of a semi-ellipse in elevation, and also in section, the shape of the soffit curve from the centre point of the boss to the face of the niche. All the cross joints in the hood should radiate round the boss by forming a number of semi-ellipses. The brick courses of the niche should be cut and divided into lefts and rights. The bevels also must be taken separately for each course as it is cut, scribed or marked by the template, and finished off course by course.

Among the many other shapes of the niche body and hood, some have a semi-circular-shaped body with a semi-elliptical face, others have a segmental-shaped body and a semi-circular faced arch on the front of the hood. Less often seen are those with a semi-circular hood and body, the whole of the hood being formed in old rustic tiles, and the body formed of old English reds.

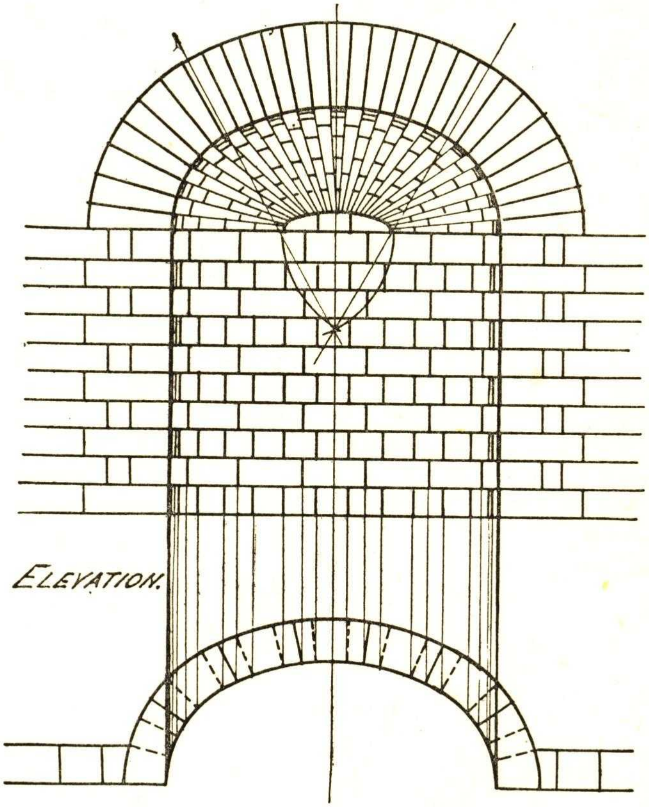


FIG. 123.

The finishing off of niches, in the matter of hoods, mouldings, sills and decorative courses, lends itself to endless ornamental variations, which are carried out in accordance with the drawings supplied by the architect, and also often furnish opportunities for the display of skill and artistic taste by the bricklayer.

Fig. 124 is an illustration of the section of a dome, $4\frac{1}{2}$ inches in thickness, showing the cross joints which radiate from the centre point on the base line at A. The dome is usually built on a centre with a plaster face finish, or at times, the finished face of the dome is composed of wood. They are built in a similar manner to that of the niche, with the circular courses marked on it from the base to the crown. Usually the dome is built of $4\frac{1}{2}$-inch rings. A perpendicular rod is generally erected on the centre point of the wooden centre, and a trammel or radius rod is then fixed to it at point D. The centre rod AB should be round and fixed in a slot at point A, so that it can revolve freely round. The radius rod BC can be fixed to it, and the courses marked from the base upwards, by the bottom point of the radius rod at C. The length of the rod will have to be reduced each course, as it proceeds to the top of the dome, as shown, D and E. These of course are all the bed courses. Fig. 124 also shows plan of the marked courses. The bond can then be marked out from the springing to the small boss at the centre of the dome. The radius rod in the elevation reaches to the third bed joint up from the base at the point. The other three courses down to the springing can be measured off by the same way as in obtaining the extrados points in a semi-ellipse, for the position of the voussoirs. All the bed joints above that can be done in the same way. The bed joints are then drawn round in horizontal circles before the bond is marked on them, as previously mentioned. Lines C and D on the plan both radiate from the springing to the crown of the dome to point E, at which it finishes with a small circular dome piece. This practically serves the same purpose as the boss piece in the niche, by enlarging the width of the bricks which finish on the outside circle of it. Lines C and D, which radiate to E, form lines for taking the bevels and moulds of the bricks. The bevels for the bed joints can be taken in a similar manner to those of the niche. The lines

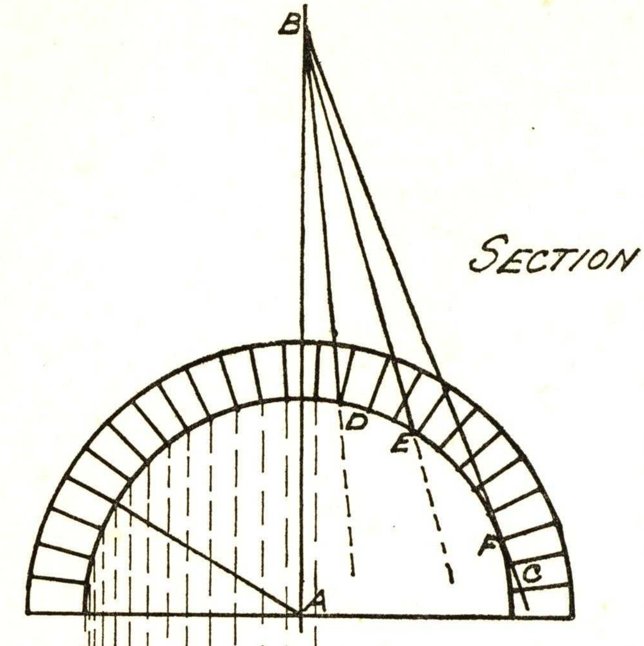


FIG. 124.

CD also form a guide for the setting out of the bond, starting from these points, and eventually working round to them. The line AB shows the centre line at the base of the dome.

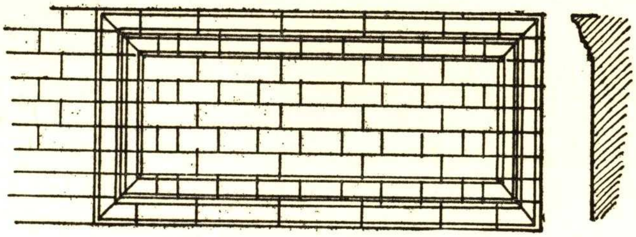


Fig. 125.

Panels. — Fig. 125 is an illustration of the elevation of the moulded panel, with two courses of moulded bricks surrounding it, showing the mitres at each angle, with plain ashlar work in the centre. At the right hand side is shown the section of the two moulded courses, and the plain work recessed on back.

In Fig. 126 we have an illustration of a moulded projecting key. This is composed of nine courses showing in the elevation in the same way as the formation of an arch with key brick course in the centre. These bricks can be cut in the box, and worked to the various templates and soffit bevels. Two moulded courses are shown to form the top finish of the key. The projections are shown in the section, giving the

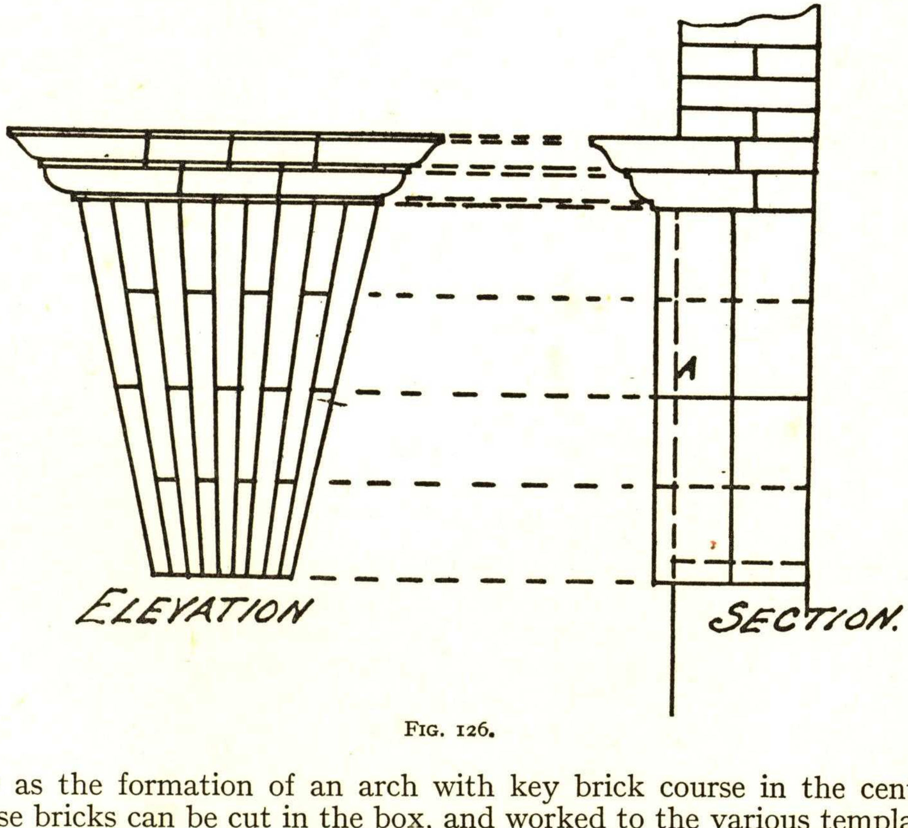


Fig. 126.

key projecting from the face of the arch about 1½ inches. The vertical dotted line A indicates the face of the arch.

Oriel Windows.—In Fig. 127 we have an illustration showing the elevation and plan of an oriel window built in gauged work. The plan shows the face line of the wall indicated by an arrow. The centre point at A shows the centre of the oriel window. From this point at A, all the courses should be radiated and struck. The external curves in the brickwork, which are all semi-circular in shape on plan, can be cut in boxes to a mould or template, the same as in the niche. The external curves of the bricks in the elevation can be taken with the bevel at each course as it proceeds upwards, by placing the bevel as shown, the stock of which should be in a horizontal line on the bed joint, and the blade of the bevel fixed in position to the external curve that may be required. All the faces of the bricks are of a double curvature. The moulded bricks are treated by the same method.

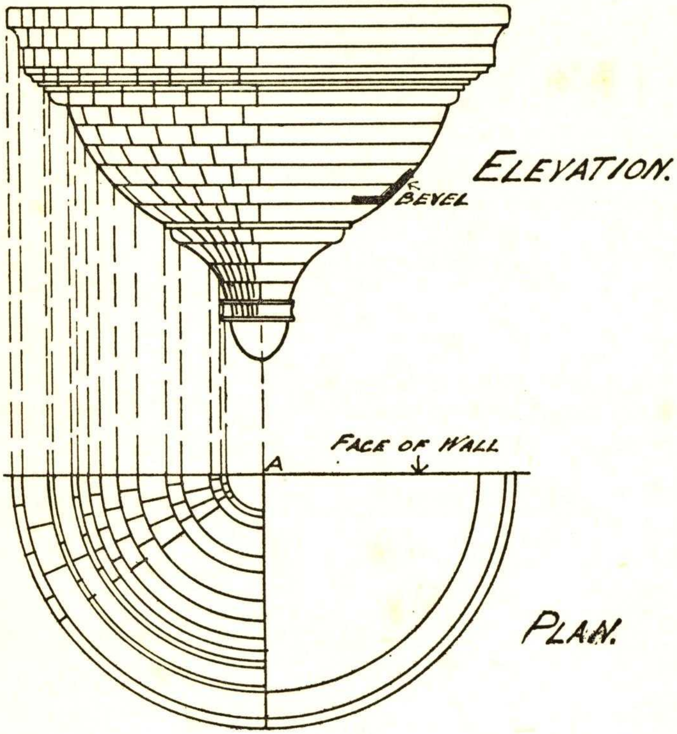
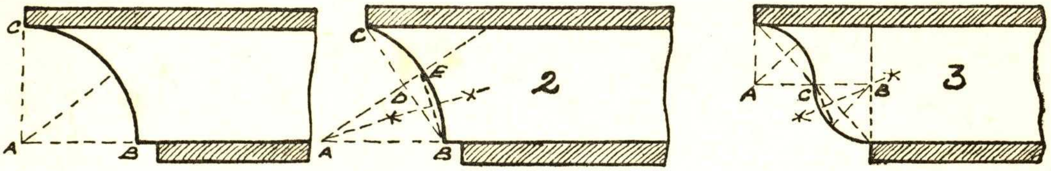


Fig. 127.

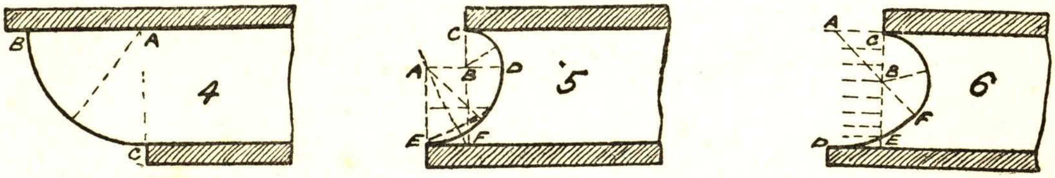
Mouldings for Cut and Rubbed Work.—The mouldings, as seen from Figs. 127 and 128, are of various shapes, and used in different positions, such as the bases and heads of columns, moulded soffits, moulded jambs, panels, cornices, etc. Two templates are usually made from each of the patterns, and fixed to each end of the cutting box, and the bricks sawn and finished to the required moulding. The first moulded brick shown is of the shape which is known as Cavetto, formed with a curve which caves inwards. The striking point for scribing the curve is at point A, which should have a radius equal to AB to scribe the curve from C to B.

The second in the illustration is another form of the Cavetto. The base line AB should be extended to A and C and B connected. Then divide into two equal parts, and draw centre line D. Take the rise of the curve from D to E, as in the case of the segmental arch ; connect EB by straight dotted line ; bisect the line EB and where the bisection line cuts the centre line will be the striking point for the curve. The striking point is therefore at point A. Place compass on point A, extend to B and draw the curve from B to C.

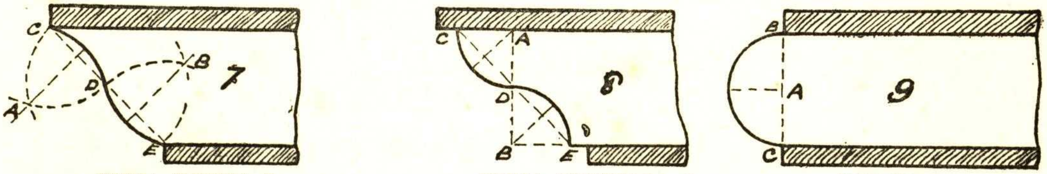
In No. 3 we have an illustration of a compound curve, which is called the Cyma Recta. This is formed in practically the same way as the preceding figure, there being two segments instead of one, the striking points being at A and B, and the intersection point of the two arcs being at point C. The striking out is shown for the lower arc ; the top arc is treated in the same way.



CAVETTO 1 & 2 CYMA RECTA 3



OVOLA 4 SCOTIA 5 SCOTIA 6



CYMA RECTA 7 CYMA REVERSA 8 TORUS 9

FIG. 128.

In No. 4 we have an illustration of another curve which forms the moulding to the brick called the Ovola. To form this, connect line CA ; then with compass on A, extend to C, and with a radius which is also equal to AB, draw an arc from C to B.

No. 5 is another illustration of a compound curved moulding called the Scotia. This is in the form of a large and small segment. The striking point for the top arc from C to D is at point B. The striking point for the lower arc from D to E is at point A. The intersecting of the two arcs is at point D.

Another version of the Scotia is seen in No. 6. To form this, draw the vertical line EC: divide it into six equal parts; take the third division point downwards from C, which gives the striking point B for the arc C to F. Then take a horizontal distance from C, equal to CB. This will give the striking point at A, which is the striking point for the arc F to D. F forms the intersection point of the two curves.

The Cyma Recta curve is given in No. 7. This is similar to illustration No. 3, but the convex of the curves are not so pronounced. Draw line CE; divide it into two equal parts; divide again the line CD and DE into two equal parts; draw centre line; then draw arcs from CD and DE which will cut the centre line at B and A. These give the striking points for the two arcs. The intersection point of the two arcs is at point D.

The Cyma Reversa moulding is given in No. 8. In this form of curve it will be seen that we have the reversal of No. 3, at points A and B.

Finally, in Fig. 9, we have an illustration of the curve known as the Torus. This is struck out in the form of a semi-circle from point A.

CHAPTER XII

TERRA-COTTA AND GLAZED WARE

Terra-cotta—Methods of Manufacture—Advantages and Disadvantages—Bedding of Terra-cotta Blocks—Glazed Ware—Manufacture of Glazed Ware—Varieties—Manufacture of Stoneware—Bedding of Glazed Ware—Applications.

A MARKED increase in the use of terra-cotta and glazed faience or stoneware blocks for both public and domestic buildings is noticeable.

The use of terra-cotta (moulded blocks and architectural features fired in kilns, fireclays and brick earths) is no new thing with us.

In England during the later phases of Gothic architecture brick clay was well moulded and also carved, especially for domestic work both on exterior and interior decoration. The tall chimneys, beautifully wrought with geometrical patterns and formal flowers, heraldic devices, etc., of the Tudor period are well known, fine specimens being seen at Hampton Court and elsewhere. This was continued during the Stuart period, good examples of this style being seen at Holland House, Kensington. It then appears to have gone out of fashion, to be revived in the 18th century. In the following century there was a still more marked revival, when the improved body was composed of potter's clay (sometimes with the addition of broken earthenware), crushed flint, and sand. Factories for the production of vases, flower pots, fountains, even benches, columns or capitals for columns, bas-reliefs and garden statuary sprang up all over the country. Notable pieces were produced at Mortlake and Hounslow and also at Lambeth. Some of this work, more than a century old, is to be seen on Buckingham Palace and Somerset House.

Glazed ware, except in the form of tiles, was scarcely known in England until after the third decade of the 19th century.

Both terra-cotta and glazed ware are of great interest to brickwork craftsmen, but require understanding and special handling. They are particularly worthy of study because there is a tendency among contractors and others to class this kind of work as a separate trade, an attitude for which there is no real justification.

TERRA-COTTA

Terra-cotta (which is merely the Italian equivalent for cooked, or baked, earth) is made from clays and refractory brick earths, carefully selected and prepared by washing or other processes, including blending, for the purpose. They must be capable of withstanding high temperatures in the kiln without cracking, too much shrinking or vitrifying.

There are several varieties of clay which are used in its manufacture, such as the red London clay, the blue and red clays found in districts of Devon and Cornwall, also at Ruabon in Wales. These clays after preparation contain a large percentage of silica and a small percentage of alkaline matter, a combination which makes the clay refractory, while the oxide of iron present, which varies in quantity, gives the terra-cotta the various shades ranging from a pale yellow or buff through a whole series of reds to deep chocolate brown. The buff-coloured terra-cotta is used extensively in London and the surrounding districts and forms a good combination with the red building brick. The Victoria and Albert Museum and the National History Museum are good examples of this work.

Methods of Manufacture.—In some districts the method of manufacture is to take the dry clay fresh from the bed, or after washing, to the pug mill, where it is mixed thoroughly to the proper consistency for working on the slip kiln. Materials such as ground flint, sand, and stone, are very often added to this clay, these being selected with a view to prevent excessive shrinkage during the burning process of the terra-cotta. The blocks are usually hollow and contain internal divisions of a minimum thickness. The reason for making large blocks hollow is to minimise the shrinkage in the burning of the clay and the weight, and also to economise in the quantity of the materials. The blocks being formed with hollows also greatly expedites the drying operation as mentioned later.

The material is then cast in ordinary moulds for blocks, or otherwise in moulds specially designed by the architect for decorative work. The moulds are generally made of plaster-of-paris, designed to give castings slightly in excess of the dimensions required in the finished article, in order to allow for shrinkage. Too large blocks or sections are not desirable, as excessive dimensions add to the risks of moulding, fixing, and handling. The prepared clay is pressed into the moulds by hand to a thickness of $1\frac{1}{4}$ inches to $1\frac{1}{2}$ inches. Pieces of clay called straps are then placed in position; these are to strengthen the block, especially if it is a large one.

After this has been done, the blocks are set aside for a period to enable the clay to dry and become sufficiently hard for the moulder to unmould. After the mould has been removed the casting is left again for a few days to harden sufficiently to enable the moulder to put the finishing touches to it, in preparation for the burning process. A special finish has to be applied in the case of moulded and ornamental work, figures, etc., for which the moulder or finisher uses peculiar tools, generally made of boxwood. All the blocks when once finished are numbered according to the drawings supplied, so permitting prompt and perfect assembly. When they are perfectly dry they are placed in the kiln to be burnt.

A typical composition of terra-cotta is as follows: silica, 75 per cent.; alumina, 10 per cent.; ferric-oxide, 3·6; calcium oxide, 1·2. There is a very small quantity or trace of magnesium oxide, water 5·9, alkalies and alkaline chlorides ·5, and 7·7 of various organic matters.

ADVANTAGES AND DISADVANTAGES OF TERRA-COTTA

The principal advantage of this material is its strength, hardness, and great durability against the external elements of the atmosphere; also it lends itself readily to various forms and designs in architecture. The disadvantages are: liability of breakage in transit, also the material must be handled and packed carefully to prevent the exterior surface from being chipped. If this occurs, a great amount of time is wasted in remoulding another block to take the place of the broken or chipped one. This can be avoided by the workmen handling the material in a careful manner. Another disadvantage is the unequal shrinkage during the process of burning; regulating the amount of heat required for the burning of each block will greatly help to remedy this defect. If the moisture has not been extracted from the clay sufficiently when the raw block is put into the kiln, it will be liable to twist and warp during the burning process. Blocks which warp and twist in the burning will fit very badly when they are placed in their relative positions in the construction of a building. Such blocks should be rejected by the builder. Usually provision is made for this in a specification.

Terra-cotta should weigh about 50 to 64 lb. per cubic foot.

There is a type of terra-cotta fortunately not often met with. It has a coarsely prepared body with a thin coating of finer materials. Unless both materials have been carefully prepared and tested for co-efficiency of contraction and expansion, cohesion is bound to be defective and trouble will sooner or later arise. Such blocks are more easily damaged in handling, and do not resist well either impact or vertical strain.

Another variety is porous terra-cotta, made by burning a mixture of clay and sawdust, the sawdust burning away in the kiln and leaving a spongy mass. These are very useful for partitions, flooring, and fire-proofing work generally, such as casing iron pillars, girders, etc.

It may be generally stated that of the many forms in which clay is presented as a building material, terra-cotta possesses special interest, now that questions of surface texture, colour, shape, and size are so much discussed.

All these characteristics have their influence, both in the labour and art sides of building. The diversity procurable in this material for each particular enumerated above gives it great value. For in texture we may have a hard surface, close-grained and perfectly smooth, or one as rough as the punched face of an ashlar block, with endless modifications between, partly due to the grain of the clay itself, partly to the niceties of moulding. In colour we can range from a pale yellow to a strong buff, a pink to a warm red. Shape and size are capable of almost indefinite variations, as carefully moulded pieces of very large size can be fired, expediency as to ease in handling and problems of weight distribution being the chief limiting causes.

Given fine enough clay, which will stand fairly high kiln temperatures, the terra-cotta can be moulded to any shape, with sunk or raised surface ornament, including deep, sharply defined mouldings. Much of the purpose-moulded terra-cotta, such as finials, caps for columns and copings, quoins, corbels, etc., are stock pieces; but when a reasonable quantity is desired, it is no dearer to have special models in terra-cotta than to carry out the designs in gauged brickwork or carved stone, while detail in the designer's work will be quite as faithfully rendered. Form is quite as permanent, colour even more so.

An added element of permanency as regards colour is perhaps attained by the use of glazed terra-cotta, or architectural faience. But it must be of good quality and carefully handled. By its introduction there is certainly a marked gain in colour value and surface contrasts, for glazed terra-cotta may be white, self-coloured, mottled, or with polychrome decorations; the surface may have a hard, smooth, glassy polish or a semi-matt egg-shell finish. The latter is particularly successful in the Carrara faience, made in a variety of shades and in both small and large blocks, as well as specially moulded pieces. No doubt faience has the great merit of not being easily soiled in smoky town air, even the semi-matt glaze providing resistance, the stain is speedily washed clean by rain.

Bedding of Terra-cotta Blocks.—Great care must be exercised in the setting or bedding of the blocks in the construction of a building. They should be bedded with a mortar of sand and cement in the proportion of 1 part of standard Portland cement to 2 parts of good clean washed sand.

In constructing a terra-cotta elevation the foreman is generally given a blue print to work from. This shows the entire elevation and all the blocks which are to be bedded are numbered, usually in courses, etc., from the base upwards, so that the fixer can see at a glance which blocks are required. Columns, friezes, mouldings, etc., are numbered in a like manner.

When unloading and unpacking take place, the blocks should be handled with great care, and should be placed in positions where they can be easily got at, as the fixer requires them. This method saves a lot of time and expense. For if the blocks are moved several times, when looking for certain numbers required, there is a liability of getting them damaged.

Where large or heavy blocks are in question some form of derrick will have to be rigged up in order to lift the block in position, as in stone masonry.

Sufficient mortar should be used to provide a good bed and joint;

but the joints should be as thin as possible, the ordinary pointing effects as in brickwork being avoided. The joints should not exceed ¼ inch and should be weathered. All excess mortar appearing on the surface must be wiped off without delay. Settlement in bedding should be by hand pressure as much as possible, and if the mallet is used it should be applied well away from the face.

Hollow blocks are usually (and always if performing a structural office) filled with concrete before placing in position. An efficient mixture is 6 parts of brick crushed to ¾ inch to one part of Portland cement. The blocks should be well soaked before filling.

Where holes are not provided for keying with plugs of mortar, cramps or dowels are used ; these should be of copper, or as an alternative galvanised iron, and should not approach the face.

No terra-cotta, glazed or unglazed, should be chiselled, cut, or filed.

Large drums for columns and pilasters are usually moulded with dovetailing notches, plugging holes for grouting, or notches for internal cramping. Such drums are either filled with concrete separately, or are bedded, cramped, and then filled before placing on the caps, or, especially when not subjected to great bearing weights, are left hollow. This last plan is often adopted when placed on upper floors, when these pillars have little more than ornamental value. Hollow terra-cotta columns and piers are also often utilised as casings for steel or iron stanchions.

The greatest care is necessary with all this kind of work, though more particularly when the surface is decorated with moulded ornament, to see that there is perfect alignment of sections and decorations both horizontally and vertically. So level and plumb line should be in constant use.

GLAZED WARE

For some years past the tendency has been to substitute glazed faience or stoneware for unglazed terra-cotta, especially in positions up to 6 to 10 feet from floor level, or in situations subject to attack from smoke or chemical fumes.

The late Mr. Ralph Knott, F.R.I.B.A., well said :

" It seems a curious thing that with an atmosphere in the towns often full of acids and soot, and which covers all our buildings with a dingy pall, we should be loath to adopt the materials that can be cleaned at intervals. Faience has been used with success . . . glazed brickwork is practically confined to lighting walls and back parts where reflected light is necessary. . . . I am sure quite a good effect could be obtained if a light joint were used of a generous width, and the whole building throughout in terms of brickwork. . . . Seconds, in my opinion, are far preferable to firsts from the point of view of appearance, much more variety in colour and glaze being obtainable, and the hard unsympathetic effect so often objected to is eliminated in consequence."

Manufacture of Glazed Ware.—Architectural glazed ware may vary greatly. It includes glazed terra-cotta, faience, and special bodies closely approaching stoneware. Like terra-cotta these are cast in specially designed moulds, and when unmoulded and dried they are glazed by dipping or spraying. In the best class of work they receive a coat of engobe before being glazed. The blocks may be decorated in colour prior to glazing, or the glazes may be tinted. Some ware is salt-glazed. In good work precautions are taken that the glazed body to which it is applied has the same co-efficient of shrinkage. If there is a difference in shrinkage there cannot be the necessary cohesion, and hair cracks or even deep fissures will appear either during firing or subsequent cooling, or still worse, after being placed in position and exposed to weathering conditions.

Imperfect cohesion between glaze and body, or a too hard, inelastic brittle glaze, is apt to lead to chipping, so exposing the unprotected body.

Chipping and fissuring besides being unsightly are serious defects, resulting in discoloration and possibly decay.

Varieties.—Apart from glazed terra-cotta and faience (ordinary brick earth or potter's clay) there are many superior varieties of materials. For instance, Doulton's " Carrara " has a hard white body with an opaque egg-shell glaze, which may be left white, cream-coloured, or given delicate shades of colour. It has the appearance of finely dressed unpolished marble, yet is quite impervious. Lambeth faience, on the other hand, has a terra-cotta body, which is dipped in coloured glazes before refiring. This is representative of a class of glazed earthenware that will take soft or brilliant colours, and proves very useful, especially for façades, decorating corridors, for the framing of doors, fountains, benches, etc.

For mural decoration two other types deserve notice, the vitreous fresco and the stoneware polychrome. In the first non-glossy enamels are painted on terra-cotta slabs and then refired, having a very pleasing, soft effect, suitable for purely decorative and for pictorial pieces. In the stoneware polychrome the enamels are painted on the hard whitish body before firing. This produces durable effects that will withstand hard out-door weathering.

There are other kinds, differing more or less according to the manufacturers producing them, the quality of the body, but more especially the treatment of the surface. The handling of all of these, however, presents no marked difference, unless it be in the matter of blending colours, but as all sections are usually numbered, this is a matter outside the province of the operative.

Manufacture of Stoneware.—The clay which is used in the manufacture of stoneware is obtained from the lias deposits. Good beds of this clay can be found in Devonshire and also in Dorsetshire, and small beds in various other places. This particular clay consists of a large proportion of silica and alumina, the proportions being 75 per cent. of silica and 25 per cent. of alumina. There is also a small percentage of iron, calcium, and various other organic matters.

The preparation of the clay for the manufacturing of this material is similar to that which is adopted in the manufacture of bricks, materials being added to it to prevent excessive shrinkage or contraction which occurs in the burning of this particular clay. For this purpose ground glass, ground stoneware, or sand is added in the proper proportions. The clay when burnt is practically of a non-absorbent nature, but to ensure absolute non-absorbency of the clay, and at the same time give it a better wearing surface, the stoneware is glazed whilst in the process of being burnt in the kilns. This is carried out in the same manner as in the glazing of salt-glazed bricks, by adding sodium chloride whilst the clay is in the process of being burnt. This is volatilised by the heat and forms a vapour which is decomposed or broken up by the silicates of alumina with which it combines and forms a glass, the chloride passing out of the kiln. The sodium chloride in vapour form thoroughly penetrates into the small holes or pores of the clay while in the process of being burnt. This forms a complete coating of glass all over the surface of the clay.

Bedding of Glazed Ware.—The bedding of every description of glazed ware requires even more care than with unglazed terra-cotta. Large blocks of terra-cotta and faience are usually moulded so as to give a key in bedding. The fitting together should be carefully done. The mortar should be rich, made up with fine sand, and the bedding should be kept as thin as possible. Faience should have the glaze carried well over the sides. All chipped sections should be rejected as being both unsightly and dangerous to durability. In any case, care is required in laying. The layer of mortar may be somewhat thicker than with ordinary terra-cotta, and the pointing made flush with the surface. Weights should bear well on the flat bed, not on the edge of the blocks. Metal ties, if used, should not come near the surface of the wall. But with due attention to such simple precautions as these, the handling of terra-cotta and faience, whether for complete facing or decorative details, offers no real difficulties.

Close attention should be given to levelling and vertical alignment.

APPLICATIONS

Terra-cotta, as already stated, is invaluable for decorative architectural detail. So are the glazed varieties, with the additional advantages of giving colour and being practically uninfluenced by weather.

Vividly rich glazes are now frequently used for architectural terra-cotta, and these often look well when it is desired to give prominence to a string course, a cornice, or any similar feature, and again for banding, panelling, or forming friezes in interior work. But for ordinary exterior wall facing, even as regards ornamentation, the softer tones are usually most suitable. However, any colour scheme, be it in the higher or minor key, can be carried out by means of faience, contrasts even being procured by the use here and there of unglazed terra-cotta. Commonly, it is the terra-cotta blocks which predominate, with detail carried out in the raised variety.

Polychrome figure panels and portrait medallions, usually flesh-colour relief on pale-tinted backgrounds, have been introduced both on the interior and exterior decoration of buildings for a good many years past. They have withstood atmospheric effects very well. Greater boldness is now being shown in the artistic modelling of architectural faience. The relief is often very high, the rounding giving sculpturesque effects. With these has come the greater use of colour, three or more being used on toned backgrounds. Some of the work may well rank with that of Della Robbia, and has been found worthy for memorial panels, archways, and so on. It has also been utilised for the construction of chimney-pieces. We have in mind examples of recent efforts of this kind, including part of a commemorative monument and two charming wall panels, each distinctive in its way, and thus demonstrating the diversity of its application.

Terra-cotta is largely used in fireproofing and glazed ware in sanitary work, for both of which purposes it is admirably suited, being carefully selected and bedded.

CHAPTER XIII

SLATING AND TILE LAYING

Slating—Slates—Quality of Slates—Parts of Roofing Slates—Testing for Absorption—Tools—Slater's Hammer—Dog—Zax—Square—Chalk Line—Slate Ripper—Gauge Stick—Pitch of Roof—Preparing Slates—Sizes of Slates—Nails—Nailing—Head Nailing—Number of Slates required for Roof—Centre Nailing—Open Slating—Asbestos Tiling—Tiling—Plain Tiles—Pantiles—Torching—Ridge Tiles—Floor Tiling—Tile Hanging—Wall Tiling—Types of Tiles—Tiles in Arch and Lintel Work—Tile Data: Plain Tiles—Pantiles—Broomhall Tiles—Paving Tiles.

SLATING

SLATING new roofs and repairing old ones is sometimes done by the general bricklayer, especially in country districts where there is not always at hand a slater who specialises in the work.

Slates.—Slate is a fine-grained rock material possessing many of the properties of clay. It is stratified, so can be split into thin layers or slabs. Some of the best slates for roofing purposes, damp-proof courses, etc., are obtained from Westmorland and Bangor and Portmadoc in North Wales. The grey greenish and green slates come from Westmorland, the blue and red coloured slates from Bangor.

Qualities of Slates.—A good slate should possess the following qualities—

(1) It should be hard and non-absorbent.
(2) Of an even texture, and free from knots, streaks, or veins.
(3) Of even thickness.

If the slate is soft and very absorbent, or is veined upon its surface, it will crack and split under pressure. Dampness and frost also affect the soft slate. A good slate should be rough to the touch, and when struck should give a distinct metallic ring, a dull sound indicating defects or poor quality. Poor quality is also indicated by an earthy smell when the slate is dipped in water.

Parts of Roofing Slates.—The *head* is the upper edge or top end of the slate. The *tail* is the lower edge or bottom end of the slate. The *back* is the upper surface of the slate. The *bed* is the under surface of the slate, which lays on and faces the battens to which it is nailed. The *lap* is the distance which a slate overlaps the next slate but one beneath it. The *margin* of the slate is that part which is exposed to view. The *gauge* is the depth of the margin.

Testing Slate for Absorption.—Place the slate on its edge or end in a small tank of water. The level of the water should be about half the depth of the slate. If, after twenty-four to thirty hours' partial immersion, the water does not rise to the extent of more than $\frac{1}{8}$ inch to $\frac{3}{16}$ inch in the slate itself above the surface of the surrounding level of the water, the slate is practically non-absorbent, but if the water rises in the slate to the top of it, it is considered a bad slate, very absorbent and being of a soft porous nature. The slate should be first weighed in a dry state before being immersed in water, left in the water for the above period, and then weighed again.

TOOLS USED FOR SLATING

These were illustrated in the chapter on Tools and are as follows: *slater's hammer*, the *dog*, the *zax*, *square*, *chalk line*, the *ripper*, *gauge stick*.

One end of the slater's hammer is flat for driving in the slate nails, the other end being sharp-pointed and used for holing the slates. At the side of the head of the hammer there is a clawlike projection, which is used for extracting nails, and is brought into use in old and new roofs. In old roofs it is used for extracting old nails, and in new roofs for extracting bent or misdirected nails which are not driven in properly.

The Dog, on which the slates are trimmed and cut for different purposes, is a shaped piece of wrought iron, provided with two spiked projections; these are driven into position generally in a piece of deal 3 inches by 9 inches. The straight horizontal portion forms a straight edge upon which the slates are placed at an inclined position to be cut by the zax.

The Zax is used for cutting and trimming the slates, and also holing them. This tool consists of a blade 9 inches in length and 3 inches wide and about $\frac{1}{4}$ inch in thickness. The handle, which is attached to it at one end, is made of wood; the bottom edge of the blade is levelled and sharpened for cutting purposes, and at a point in the centre of the top edge of the blade there is a spiked projection about $2\frac{1}{2}$ inches in length. This is used for holing the slates.

The Square which the slater uses is generally made of steel about 12 inches in length each way from the angle. It is sometimes marked with inches, indented in the face of the square. This is very useful for measuring various portions of the slates, such as the gauge of the slate or the length of the eaves course or half slates.

The Chalk Line is very useful in making marks at the bottom edges of the slates to form a perfectly straight row of slates in each course as the work proceeds. It generally consists of a line about 50 feet long, which is wound round a box reel, the line being whitened with a piece of chalk when required for use.

The Slate Ripper consists of a shaped piece of steel comprising a handle and blade all in one piece. The blade is flat about $\frac{1}{4}$ inch by $1\frac{1}{2}$ inch, and diminishing to $\frac{1}{8}$ inch at the extreme end, and at this end there is a flat-shaped piece of steel about 2 inches by 2 inches with two angle cuts at the back of it. These are used for clasping the nails when drawing out old slates from a roof. The method generally used when drawing out a broken or cracked slate is to push the blade of the ripper under the cracked slate until the extreme end projection is level with the nails. The ripper should then be pushed sideways so that the notch in the ripper can take hold of the nail. The ripper is then sharply drawn out, and with it the nail. The second nail in the slate can be extracted by the same method. When the two nails have been drawn, the cracked slate should be taken out. This is done by again pushing the ripper under the slate with one hand, and pressing the slate to be drawn out with the other hand on to the blade of the ripper. The ripper should then be drawn outwards, bringing the old slate at the same time on the blade.

The use of the 2-foot rule needs no explanation as to its usefulness in relation to all craftsmen.

The Gauge Stick consists of a piece of planed wood about 1 inch by ½ inch, and about 2 feet 6 inches long. One-half of its length is rebated to form a shoulder for the edge of the slate to rest against. From this shoulder the length is gauged, so that the nail at the end of the stick corresponds with the length between the edge of the slate and the holes. Thus the nail, fixed in position, is used for marking the positions of the holes in the slates.

Pitch of the Roof

The pitch of a roof should greatly depend upon the material which is going to be used. For ordinary slates, the pitch of the roof should be about 26 degrees. The pitch of the roof is the angle which its sides make with the horizon. Tiles are used on roofs which have a pitch from 30 degrees to 50 degrees or more. A high-pitched roof is better than a low-pitched one, because the rain will run off a high-pitched roof quicker than a low one, while the wind and snow are not so likely to blow under the slates, wrench them upwards and cause cracks. The lower the pitch, the more liable are these nuisances to occur. The type of slate used should vary according to the pitch of the roof. If a small slate is to be used, the pitch of the roof should be high; if a large slate is to be used, it should be lower. High-pitched roofs are more expensive than low-pitched roofs, because there is more surface of roof to be covered for the same span.

Preparing Slates

Slates are squared and cut to various sizes. All the edges are squared except the heads, and these are generally left rough. When trimming slates, they should be held with the smooth face upwards. The holes for the nails should also be made from this side. When the slates are laid in position on the roof, the smooth face of the slate should be laid downwards upon the boards or battens. The reason for this is that when making the nail holes on the smooth surface of the slate, in driving the hammer through the hole, a certain portion of the slate around it breaks away on the rough surface side of the slate. The same thing occurs when trimming the edges of the slate. A certain portion breaks away on the rough side, forming a chamfer round the edges on the rough side. This also happens with the nail holes. The portion which falls away when driving the hammer through the hole forms a countersinking for the nail heads to fix into, leaving the surface of the slate flat with no projections. This enables the slate above it to be laid solid upon it. Therefore, the countersinking of the nail holes which is formed in the slates, and also the chamfered edges formed in the slates, should show face upwards.

Slates should be laid closely together, and the bottom edges should be in a straight horizontal line. All slates should be laid solidly over the previous layers. If hollow, the slates are liable to be cracked or broken, when roofs are repaired, by the men walking on them. The bond of the slates should be studied. The vertical joints of each alternate course of slates should be in a vertical line with each other, and a lower course should be vertical and central with the course above it. All slates should be holed twice, an inch from the top or central holes, and two nails driven into each slate through these holes, into the slate battens. The heads of the nails must be driven in, and show a level surface. When nails are left higher than the surface of the back of the slate, it causes slates in the next row to lay unevenly or hollow. Sometimes slates are only secured by one nail. This is a bad method, and is very often the cause of slates slipping down when the wind gets at them, and tends to loosen the single nail which holds them. Slipped slates, of course, leave more or less a hole in the roof, through which rain and wind will enter. Therefore it is very essential that all slates should have a lap of at least 2½ inches. In a roof which is rather flat, the slates would require a bit more lap, say 3 inches or more.

SIZES OF SLATES

There are various slates of different sizes which are used, viz.—

Name of Slate.	Size.	Gauge for 3-inch. lap centre nailed.	Gauge for 3-inch lap nailed 1 inch from head.	No. of squares covered by 1200.	Weight of 1200 1st quality.	No. required to cover 1 square.	Weight per square 1st quality.	No. of Nails required per square.
	inches.	inches.	inches.		cwt.		cwt.	
Singles (Smalls) . . .	12 by 8	4½	4	2·8	17½	430	6¼	860
Doubles (Smalls) . . .	13 by 6	5	4½	2·5	15	480	6	960
Ladies (Large) . . .	14 by 12	5½	5	5·0	31	240	6¼	480
Ladies (Small) . . .	16 by 8	6½	6	4·75	25	300	5½	600
Viscountesses . . .	18 by 10	7½	7	6	36	200	6	400
Countesses	20 by 10	8½	8	7	40	171	5⅔	342
Princesses	24 by 14	10½	10	12·75	70	94	5½	188
Duchesses	24 by 12	10½	10	10	60	125	6	250
Empresses	26 by 16	11½	11	15·5	95	79	6½	158
Marchionesses . . .	22 by 12	9½	9	4·9	55	130	6	260

Nails.—Copper and zinc nails are the best for slating. These are generally used for good-class slating. When repairing roofs, old zinc nails can be drawn out easily with the slate ripper. They bend easily and do not crack the slates as in the case of iron nails which are sometimes used. Iron nails should be galvanised and may be dipped in oil to preserve them from the weather. Iron nails which have not been coated should not be used, as they rust and split the slate round them, causing it to become loose and slip down.

Nailing.—Slates are nailed and fixed to the battens or boards by two methods: head nailing and centre nailing. In head nailing, the slates are holed about 1 inch down from the head of the slate. Taking this as course No. 1, the third course would cover these nail-holes or overlap the holes by the length of the lap. Fig. 129 gives an illustration of slating showing the slates nailed on the battens, the holes being 1 inch down from the head of the slates. These are Countess slates, the size being 20 inches by 10 inches. In this case, the lap is 3 inches, and the gauge is 8 inches. The small dotted circles show the position of the nails in the underneath course of slates, that is, the second row of slates in the diagram. The dotted vertical lines show the joints of the slates in the first and second courses which are not seen on the roof surface. The two lowest horizontal dotted lines represent the heads of the slates in the first and second rows. The top horizontal dotted line represents the bottom of the batten, the nails being fixed centrally in the width of it.

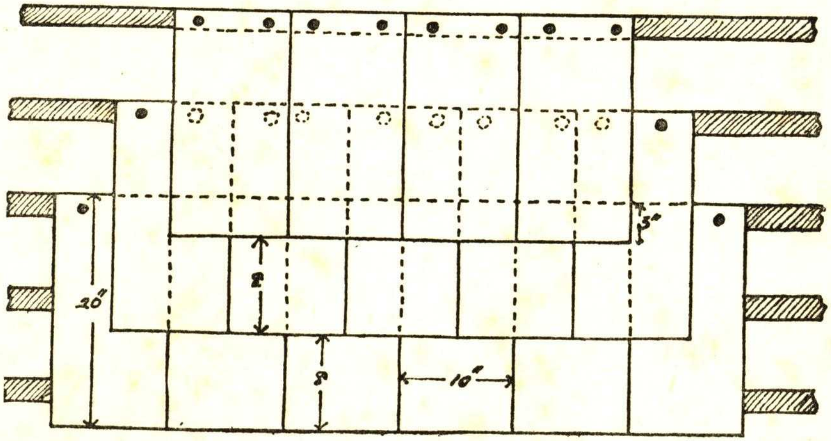


FIG. 129.

Fig. 130 is an illustration of the same method of slating, showing the section of the roof. These slates are the Countesses, 20 inches by 10 inches. The rafter is shown with the battens fixed to it at 8½ inches centre to centre. The eaves course of slates is shown, and then the first whole course of slates. There are five rows of whole slates shown. The various points of the slates are indicated by arrows. The slates are nailed to the battens 1 inch from the top or head of the slate. The back of the slate, which is the upper surface, is shown by arrow pointing

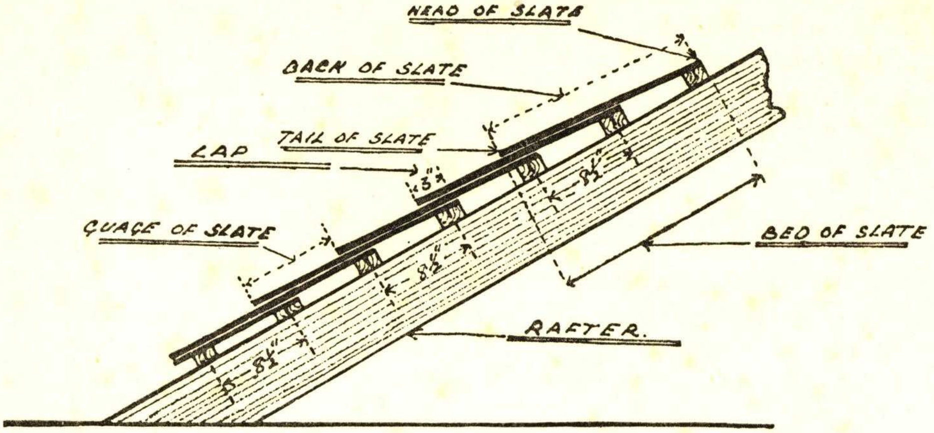


FIG. 130.

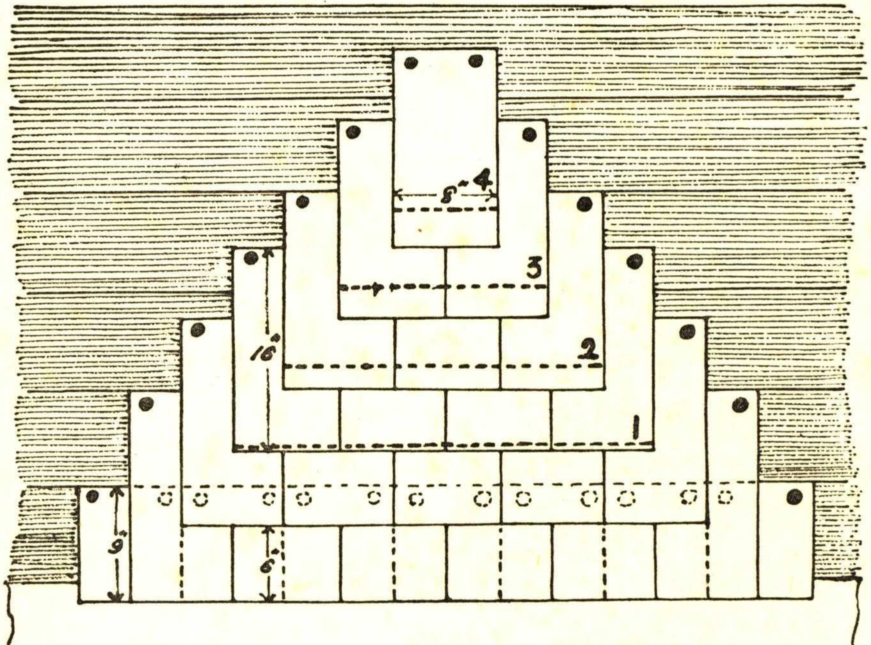


FIG. 131.

to dotted line which extends the whole surface of the slate. The lap of the slates is 3 inches as shown, while the tail and gauge of the slate are also shown.

Fig. 131 shows the method of fixing slates to the boards instead of battens. Sometimes roofs are rough deal boarded; then a layer of felt is laid on the boards and the slates fixed to the boards on this. This illustration shows the Ladies slate, or smalls. The size of the slates is 16 inches by 8 inches. The gauge is 6 inches, and the lap of the slate 3 inches. These slates are top nailed, the position of nail holes being about 1 inch from the head of the slate. The bottom horizontal dotted line shows the heads of the eaves course covered by the first whole layer of slates. The dotted circles show the position of the nails in the eaves course, while the vertical dotted lines as shown represent the vertical joints in the eaves course of slates.

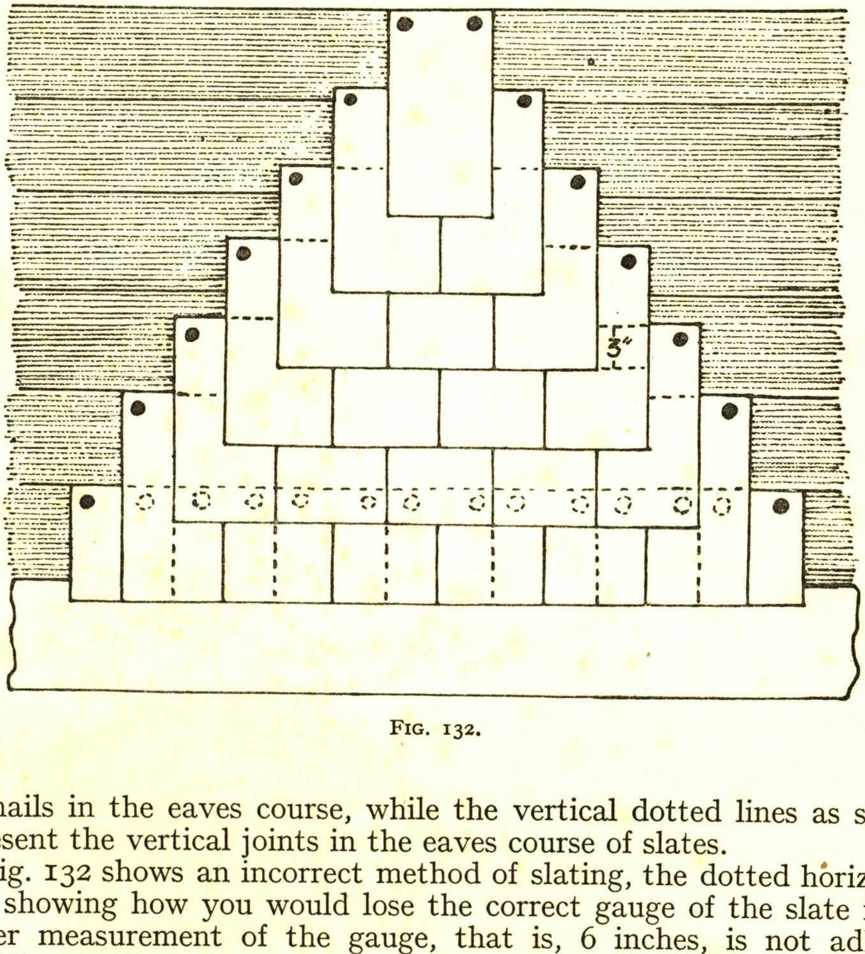
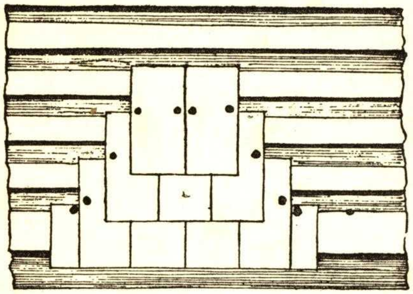


FIG. 132.

Fig. 132 shows an incorrect method of slating, the dotted horizontal lines showing how you would lose the correct gauge of the slate if the proper measurement of the gauge, that is, 6 inches, is not adhered to. The third whole course of slates, as will be seen, is laid, the gauge being slightly smaller than the correct gauge of 6 inches. The first dotted horizontal line shows where the tail of the slates should be. This is marked 1. Nos. 2, 3, and 4 show a larger discrepancy. By this it is evident how important it is to keep to the correct gauge. It is just as important not to extend the gauge of the slate. By doing this the lap of the slate will get smaller each time.

Fig. 133 illustrates slating fixed on to battens, being centre nailed. The nails are placed in a position near the centre of the slate, which equals a distance from the tail of the slate as much as the gauge plus the lap. These holes, in which the nails are inserted, clear the head of the slate below it. In the illustration will be seen the nails of the first course of whole slates, which clear the holes in the eaves course.



CENTRE NAILED SLATING

FIG. 133.

There are two positions generally in which double courses of slates are placed, one being at the eaves, and the other next to the ridge of the roof.

Head Nailing.—In order to find the gauge of a slate which is head nailed, with the holes in a position 1 inch from the head of the slate, we will take a Countess slate, the lap which we require being 3 inches. The method would be: First deduct the distance of the nail holes from the head of the slate, which is 1 inch from the length of the slate, which is 20 inches. Then again deduct the lap of the slate, which is 3 inches. This leaves us 16 inches. Divide this by 2, which represents half the distance between the length and lap. Thus we have—

$$\frac{20 - 1 - 3 \text{ inches}}{2} = \frac{16 \text{ inches}}{2} = 8\text{-inch gauge.}$$

Another example in which the slates are nailed 1 inch from the head. This time we will take a much larger slate—the Empresses, which are 26 inches by 16 inches. Thus we have: 26 inches, length of slate; deduct 1 inch and 3 inches, this being the distance of the holes from head of slate and the lap. This equals 22 inches. This is divided by 2, being half the distance between length of slate and lap, which gives us an 11-inch gauge.

$$\text{Thus: } \frac{26 - 1 - 3 \text{ inches}}{2} = \frac{22 \text{ inches}}{2} = 11\text{-inch gauge.}$$

A third example in which the slates are centre nailed, again taking the Empress slates, with a 3-inch lap: 26 inches, length of slate; deduct 3 inches, which is the lap.

$$\text{Thus we have: } \frac{26 - 3 \text{ inches}}{2} = \frac{23}{2} = 11\tfrac{1}{2}\text{-inch gauge.}$$

A fourth example in which we have the same slates centre nailed with a 4-inch lap.

$$\text{Thus we have: } \frac{26 - 4 \text{ inches}}{2} = \frac{22}{2} \text{ inches} = 11\text{-inch gauge.}$$

Number of Slates required for a Roof.—A fifth example will show us how to find the number of slates required for a roof. First find the area of the roof. To do this you must multiply the length by the breadth; the answer will give you the superficial area of the roof. Allow 6 inches for cutting each side of a margin; add to this the total which you get from dividing the length of the eaves by the width of a slate. This allows for the doubling course.

We will take an example, using the Duchess slates, which are 24 inches by 12 inches. These should be head nailed, and have a lap of 3 inches. Thus we have to find the number of slates that is required to cover a roof 15 feet by 30 feet.

Area of roof 15 by 30 feet = 450 square feet, or $4\frac{1}{2}$ squares
Gauge of slate = 10 inches
Margin of slate 10 by 12 inches = 120 square inches

Total number of slates required to cover the roof $= \dfrac{450 \times 144}{120} = 540$

Add for waste 30

Total number of slates 570

Centre Nailing.—Centre nailing is the best method for fixing slates. Fig. 133 gives an illustration of centre nailing. When slates are centre nailed, it renders them less liable to be stripped off the roof by strong winds. In the illustration the eaves course is shown. This course is nailed at the head, and the bottom part of the slates is raised. A tilting fillet of wood is generally used for the purpose. The length of the eaves course is generally about 1 inch longer than the half of the ordinary slate. The slater sometimes measures the length of the eaves by taking the gauge plus the lap, and then allowing another small margin, say $\frac{1}{4}$ inch to $\frac{1}{2}$ inch, for irregular cutting, etc.

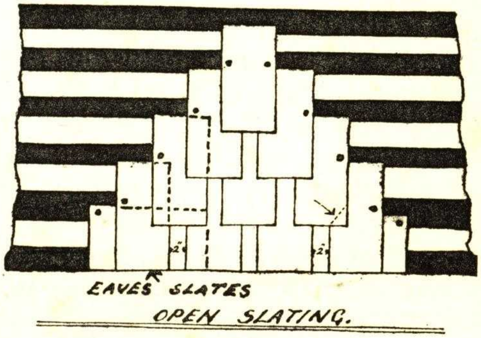


FIG. 134.

Open Slating.—Another method of slating is called open slating, as distinct from the slating as already described, which is called close slating. Fig. 134 gives an illustration of open slating, in which the slates have spaces between them of 2 inches. This is a cheap method of slating. In this method, the slates should be centre nailed, as the wind has a great tendency to find its way under the spaces and bottom corners of the slates. The eaves course is also shown by dotted lines. This course usually consists of a larger slate laid lengthwise, 24 inches by 12 inches or 22 inches by 12 inches, to suit the spacing of the slates. The dotted line across one corner of the slate indicated by the arrow shows how the wind would affect these corners and break them, and also cause the slate to become loose. In the above illustration the battens are shown black ; the nails in each course are in a central position on the battens. Open slating only requires about two-thirds the amount of slates as compared with close slating.

Asbestos Tiling

Another form of slating is carried out with the diamond-shaped asbestos tile, which has been employed extensively of late on large roof surfaces in various parts of London, especially on large cinemas. The asbestos tile is composed of fibres mixed with asbestos cement. These tiles, in the process of manufacture, are subjected to enormous pressure which intermixes the two materials when in the semi-liquid state. The tensile stress of the tile is considerable. A good-class asbestos tile will not crack or flake on the surface. They are fireproof and practically impervious, and stand the weather well. They are also much lighter than slates, and considerable economy is effected in this direction by having lighter material in the construction of the roof to carry them. The life of the asbestos tile compares favourably with any other roof material when the question of its cost arises. The tiles are very flat and even, and can be laid solidly. Condensation is one of the disadvantages attaching to them, but not to any great extent on small tiles, there being a certain amount of air which can gain access to them through the nail holes and joints. In large surfaces this condensation is more pronounced, but in large roof surfaces there is a great air space beneath the roof surface, and the inside of the building is not affected to any great extent by this cause.

Fig. 135 gives an illustration of the diamond pattern asbestos tile. This shows a rough deal boarded roof. Sometimes a layer of felt is placed on the boards, and the slates laid on this. This method gives a very good roof. The general size of these tiles, of which I have had used on various occasions, is 15¾ inches square, and cut at each side of the tile vertically, to allow for the lap, which is generally 3 inches. This lap would be suitable for a roof of 30 degrees. If the pitch is steeper, the lap can be slightly reduced, but should not be less than 2½ inches in any case. In the illustration the dotted lines show the lap. The double eaves course is shown in illustration, and consists of a row of triangular tiles marked No. 3. This course is as wide as the whole tile. These tiles are nailed at one inch from the apex. The second row, marked No. 2, consists of a little more than half of the whole tile as seen in detail No. 2. The nail holes are well above the shoulders of the tile. The whole tile is then placed in position, the lowest point coming in line with the bottom of the horizontal eaves line of tiles. Detail No. 1 shows the whole tile and the position of the nails, which are at a level with the shoulders of the tile at each side. The small piece No. 3 is nailed at the top, the bottom being tilted on a tilting batten. No. 2 is fixed so that the bottom horizontal line of each is flush. These project about 3 inches into the gutter. The whole course is then nailed into position so that the centre bottom point is level with the horizontal line of the eaves course. All the tiles should be twice nailed, one on each side of the shoulders. In the illustration it will be seen that No. 6 tile has an arrow pointing to the bottom point of the slate; there is a hole at this point, similar to all the other slates. Before Nos. 4 and 5 are completely fixed at the positions shown in the dotted circles, which are the nail holes, a copper rivet should be placed at the arrow point between the shoulders of the tiles marked 4 and 5. This should be placed head downwards, with the pin or shaft standing in an upright position. After this has been done, Nos. 4 and 5 tiles can be secured by nailing fast at the dotted circles. This leaves the copper rivet secure in position ready to be placed into the hole of No. 6 tile when it is placed into position. When this is done, the copper rivet in No. 6 tile is bent downwards, and thoroughly secures the bottom point of No. 6 tile. By this method, all the tiles are securely fixed at three points, so that when the rivet in No. 6

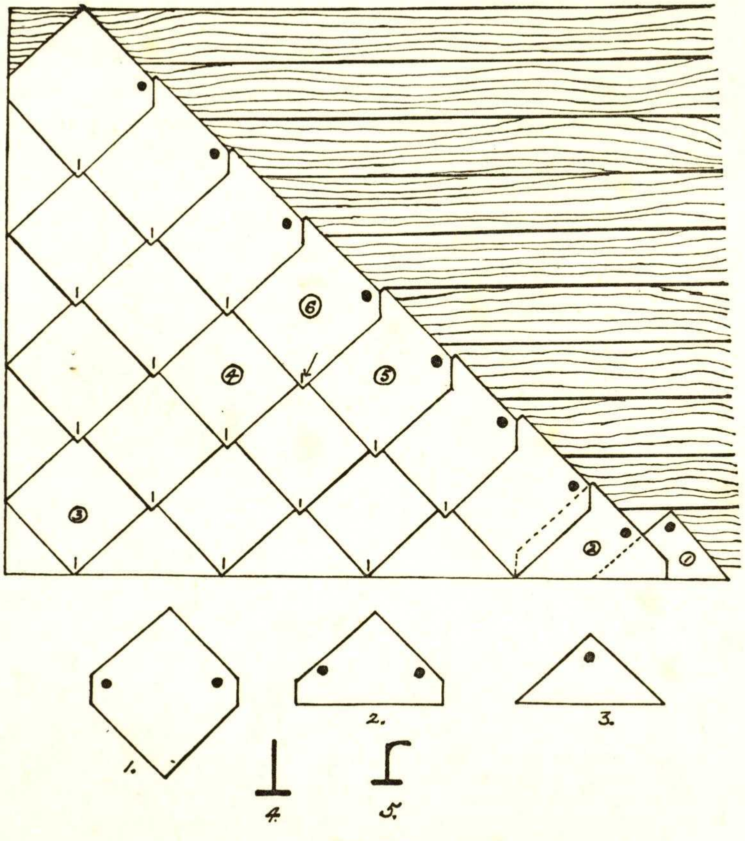


FIG. 135.

tile is bent down, it tightens itself against No. 4 and 5 tile, and makes a good fixture, so that there is no danger of the wind displacing any of the tiles. Details 4 and 5 show the copper rivet standing in an upright position with head downwards, and also the shank when bent down. The tiles are made in various other sizes like slates.

The diamond pattern of the above size, laid on a 35 degrees pitch roof, will take from 90 to 95 tiles; a few are generally allowed for breakages. These tiles are also made in various shapes especially prepared for hips, valleys, and ridges. The slates which are laid at the finished part of the roof at the gable end should always be properly bedded. Half slates and one and a half slates are used for finishing at this point, which usually projects 1½ inches to 2 inches. The under side of the slates should be pointed, and the material solid and of good quality. This part of the slating which overhangs is called the verge. The joint which is made at the under side of the slate forms the bed for the slates, and rests upon the gable end wall, and is called the collar joint.

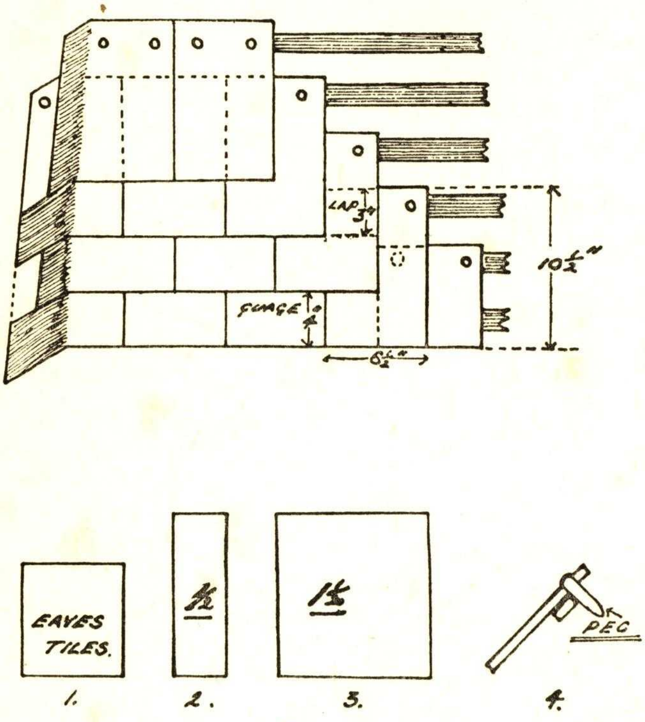


FIG. 136.

TILING

Plain Tiling.—Roofing tiles are made of burnt clay in various patterns and sizes. The ordinary plain tile, which we will take for illustration as in Fig. 136, is usually 10½ inches by 6½ inches and from ⅜ inch to ½ inch in thickness. These tiles are slightly curved both ways, that is, in their length and in their width. This gives more of an artistic effect, and enables each course to lie closer together. With these we do not get so much of the mechanical effect as we do in slating, where we get all straight lines as a rule. These tiles are made in various shades of colour, from light red to the deeper tints of brown, which give quite a good effect. Fig. 7 is an illustration of plain tiling, showing angle tiles. These tiles are laid on battens. One method is to nail each tile twice at about 1 inch from the head, and another method is to peg them in the same holes with wooden pegs. These pegs are put through the holes in the tiles, and rest at the back of the battens as shown in detail No. 4, which gives the peg in its position at the top end of the batten. These pegs or pins are usually made of hard wood, which lasts much longer than the ordinary wood. Tile battens are usually about 1½ inches square, or 1½ inches by 1 inch or ½ inch. These are also generally of hard wood in the best class of work.

Tiles are sometimes made with projections or nibs on the beds. These are placed on the battens, the nibs holding them in position by the projections being placed over the top ends of the battens. Three or four courses are laid in this manner, and every fourth course nailed. The unnailed courses are naturally subject to be lifted by the wind more so than the tiles which are nailed every course. Tiles are laid in their various positions, and the same method used for the eaves course, gauge lap, etc., as in the slates. No. 1 detail shows the eaves course tile, and also the head tile. Detail 2 shows the half tile which is used at gable ends on the verge, and No. 3 shows the 1½ tile which is used for starting the bond from the vertical points of the roofs.

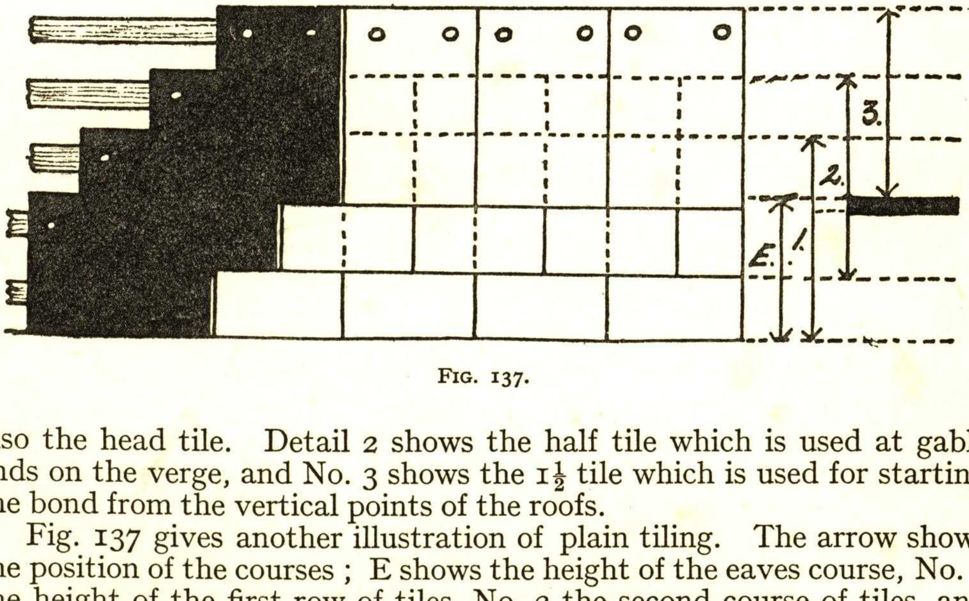


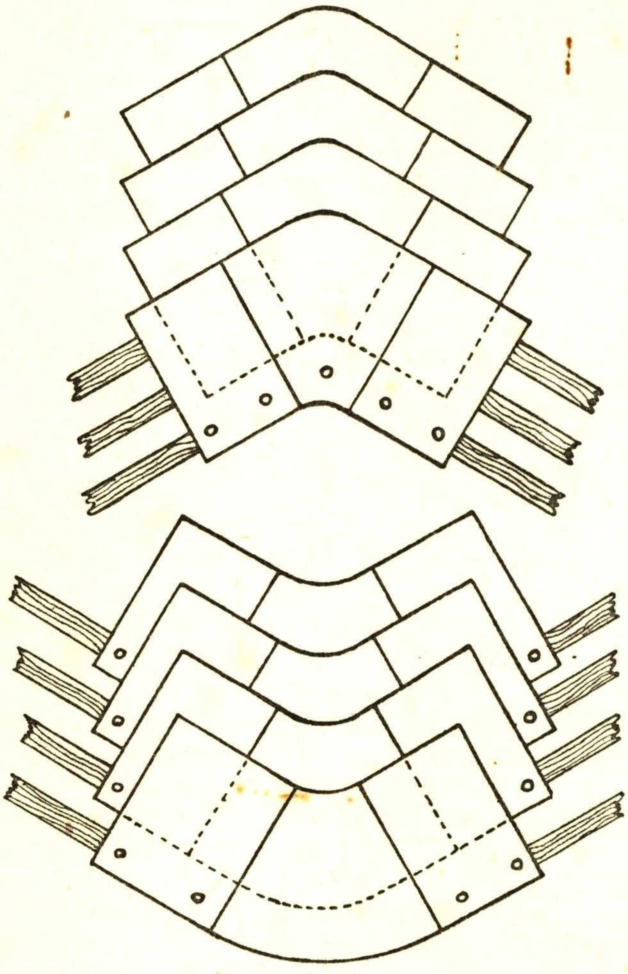
Fig. 137.

Fig. 137 gives another illustration of plain tiling. The arrow shows the position of the courses ; E shows the height of the eaves course, No. 1 the height of the first row of tiles, No. 2 the second course of tiles, and No. 3 the third row of tiles. The bottom arrow point should extend to lower horizontal line of the lap, which is indicated by a thick black horizontal line. The lap of the tiles is also shown by the double dotted horizontal lines at the side of it.

Figs. 138 and 139 give an illustration of valley and hip tiling. A central line is usually defined in the centre of the roof valley, and the tiles worked from the bottom upwards to this line, working away each side of it with the ordinary tiles. The hip tiles are usually nailed and bedded in mortar to ensure protection from the wind. The valley tiles do not require to be bedded, being in a more sheltered position.

Pan Tiles.—Fig. 140 gives an illustration of the pan tile roof. These are used for cheapness, and do not make such a good job as the plain tiles. They are usually about 14 inches in length and 9 inches wide. The roofs on which these tiles are to be placed usually consist of 4-inch by 3-inch rafters and battens on to which the tiles are placed, being kept in position by the projecting rib at the head of the tile, which hangs over the back of the batten. These tiles are sometimes bedded where the lap occurs, and pointed as indicated by arrow marks. A good lap should always be given to pan tiles. In the illustration it will be seen that the fourth course has very little lap. This method is incorrect, and shows that the wind could easily get under the tiles, and also the rain, and cause a lot of damage. These tiles are usually about $\frac{5}{8}$ inch in thickness or more. The dotted horizontal curved lines show the lap of the tile over the preceding one. About 110 to 120 of these tiles are needed to cover a square, a small allowance being allowed for breakages.

Torching.—This is the pointing of the under side joints of the tiles with lime mortar, which pervents wind from gaining access to the inside of the building. This method is sometimes applied to plain tiling as well.



FIGS. 138 and 139.

Ridge Tiles.—These are used for covering the top head courses of the slates or tiles. They are triangular in shape and cover the top courses at the ridge of the roof. They are usually made of the same material as the tile, and are also made to the various angles of the roof on to which they are to be fixed. These tiles are also made in various colours, but the general colours to be seen are red and blue. They are usually about 1 inch in thickness and are sometimes ornamented or have vertical projections on the apex. They should be solidly bedded in mortar, and well pointed to protect them against the weather.

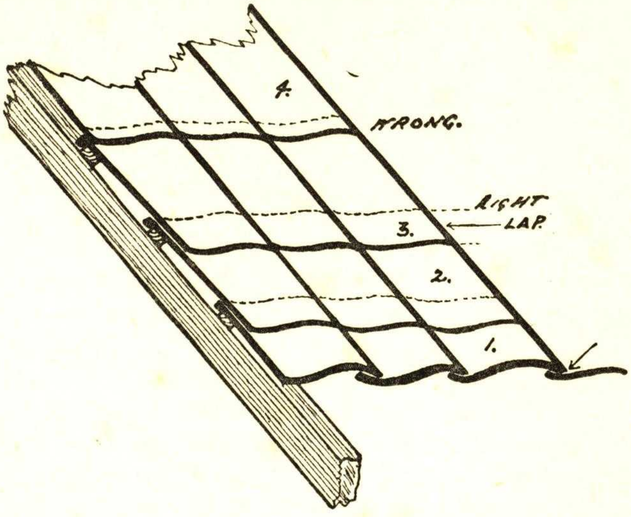


FIG. 140.

Another form of ridge covering is the slate ridge. This consists of special lengths of slate in the form of a roll. These pieces are about 18 inches in length, circular in shape on the top portion, and rebated on the under side. Fig. 141 gives an illustration of the slate roll and the side pieces of slate called the wings. The slating is shown underneath the slate wings, which are 6 inches wide. This gives a good covering and lap for the slating below the wings. The wings are made in various lengths to suit the size of the widths of the slates. The double head course is shown and the dimensions marked. The length of the whole slate is 22 inches, and the width 12 inches; the gauge is 9 inches and the lap 3 inches. The slates are head nailed as indicated by arrow. The double courses of slates at the head are fixed; the wings are then nailed into position, the holes being near the top close to the ridge board. The slate roll, which is 2 inches thick, is then screwed into position on to the ridge board, the under side rebate overlapping the head of the wing slates. These rolls are sometimes bedded in mortar and pointed after being screwed to the ridge board. The top of screw hole is then covered with a portion of red lead to ensure it being water-tight.

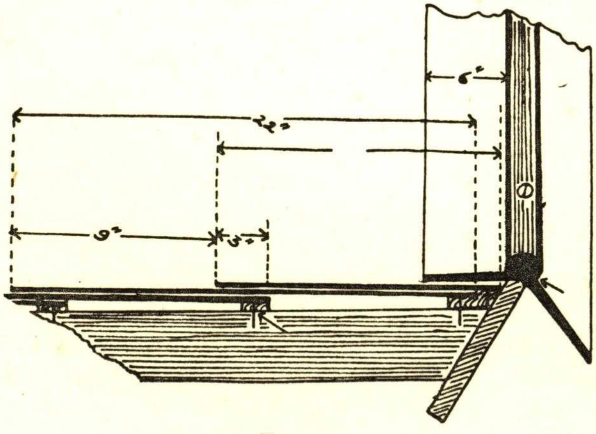


FIG. 141.

Floor Tiling.—Floor tiles are made in various shapes, sizes, and colours. Black and white and buff and red are the colours used extensively for tiling floor and steps. The stock sizes of these vary from 2 inches square to 4 inches square, but there are also various sizes such as 4 inches by 1½ inches, diamond-shaped and triangular forms, used for producing patterns and borders.

The usual method of tiling a floor upon which a bed of concrete has already been laid in preparation is to form a bed, or screed as it is called, of cement and sand. This must be perfectly level in the case of floors; in the case of steps, sometimes there is a fall given to throw off the water. Before the bed or screed is set, the tiles should be placed upon it in the correct bond, or if patterns are to be used it is always the best plan to lay a centre row of tiles to a centre line, and then work away from it on either side. Allowance must be made for the concrete base, the bed and the thickness of the tiles, so that the surface should finish exactly with the floor line. Sometimes the tiles are worked half bond. This looks very well when using tiles the size of 6 inches by 2 inches and ½ inch thick. Sometimes square tiles are worked in half bond, and at other times they are all worked in squares. When all the tiles have been placed in position on the screed, a straight edge should be used to level them over, as some of the tiles might be a little above the finished level and will require a slight tap to put them in their proper place with the others. The tiles should be grouted in, that is, a mixture of water and neat cement thoroughly mixed to a liquid state should be poured all over the surface, and so fill in all the joints between the tiles. When sufficient time has elapsed for the grout to get steady, the surplus grout which is left on the surface of the tiles should be wiped off with rags. Then, after the grout has set in the joints of the tiles, the whole of the surface should be washed off with clean water and wiped perfectly dry. Sometimes with red tiles it is the custom after thoroughly cleaning the tiles with water, and drying them, to wipe them over with a rag which has been dipped in oil to tone them down.

Quarry tiles are used for floor tiling. These are thick and are about 6 inches by 6 inches, and are often made in larger sizes. They are laid in the same way as the other tiles. The joints are a bit larger generally. They are laid in squares or half bond, or in a diamond pattern. When laying them in this fashion, the centre line should again be worked from, and triangular pieces used to make up round the wall. These joints are sometimes pointed with cement, and neatly cut off both sides with the frenchman and straight edge, or pointed with the jointer, or recessed by running a piece of stiff round wire, about ⅛ inch in thickness, and turned at the end, along the surfaces of the joints. The surplus material left after the joints have been jointed or pointed is then swept off the surface, and the tiles thoroughly cleaned or rubbed with oil to tone their colour, and also the pointing.

When laying, the tiles and the bed should be wetted as the work proceeds.

When tile paving is to be laid upon wood joists, strips of wire-mesh or other similar metal lathing are placed across the joists to receive a

1½-inch layer of concrete, on which the tiles are bedded divided in the usual manner.

If it is a case of replacing boarded flooring by tiles, and it is not possible to lower the joists to receive the metal lathing and its layer of concrete, after the boards have been removed, the strips of lathing are nailed to the sides of the joists at the requisite depth, and the concrete bed laid. The tiles are then bedded in the cement mortar to secure the desired level, that is to say, the thickness of the removed boarding. Tiles should never be laid on boards, as such a foundation is too springy. All paving tiles need solid, firm backing, or they will work loose or crack.

Tile Hanging.—Plain tiles are often fixed vertically, either on outside walls on the upper floors, or flank walls, or merely on gable ends and dormer wings. This is tile hanging, and when done, affords an admirable protection against the weather. They should be nailed twice and bedded in mortar. The surface of the wall is first roughened to provide a key, well wetted and then rendered with mortar, in which battens are bedded. In the best class of work, breeze or other fixing bricks are built into the wall in the required position, to receive the battens which are nailed to them. With nibbed tiles, however, nailing may be dispensed with, the bedding in the cement mortar being sufficient to fix them.

Wall Tiling or Lining.—Tiles for walling are made in various sizes, patterns, and thickness. They are roughened or have a series of serrations upon the back surfaces, to form a key to give them a great adherence power to the beds of mortar in which they are bedded. They may be of the ordinary glazed kind or the decorative "encaustic" type. They are laid flat against the wall in various bonds, half bonds, quarter bonds, diagonal bonds in the case of panelling, and also in various patterns, etc. Special pictorial panels or various patterns are sent already adjusted generally from the makers. The method used for forming the bed or screed for the tiles in wall tiling consists of laying ½ inch to ¾ inch of cement and sand. This is placed on the rough wall surface, and should be of a uniform thickness all over the surface, and must be vertically plumb. When applying this bed of material upon the walls, screeds of material are generally placed in vertical positions at various distances along the surface of the wall. These are plumbed, and the intervening spaces are then filled in to the exact surface of the existing screeds by means of a long straight edge, which the tiler moves in a horizontal motion backwards and forwards, until the exact position of the screed surface is obtained. When this has been done, the surface of the screed is roughened to form a key for the tiles. This is done by the tip of the trowel, or by drawing backwards and forwards against the surface three or four laths, which have to be tacked together and sharpened at their ends.

Fig. 142 gives an illustration of tiling in which the size of the tiles used is 2 inches by 6 inches and about ⅜ inch in thickness. The panel in this case is worked from a centre line and the bond set out at the bottom to work into it. When reaching that level, a moulded projection course is placed all round the panel. All tiles, before they are used, should be thoroughly wetted, and they are generally put in small tanks of clean water for a period before being used. Tiles have to be cut at various times to fit them into various positions, and to form the various bonding. The tools generally used for cutting are a small wheel or a diamond, though sometimes a small sharp chisel is used for the purpose. When cutting a tile, it should be placed on a solid surface, the tile marked, and the diamond or wheel then used with sufficient pressure on its front surface to mark the glaze. When this is done, the tile is turned over, and two or three taps with the handle of the small trowel generally breaks it clean and sharp at the place which has been marked by the diamond. If the chisel is used when cutting the tile, you do not get a sharp arris at the cut; when striking the chisel, small pieces of glaze generally fly off at either side of the chisel, but with practice, even with the small chisel, a good clean cut can be made. The ragged edges at the back of the cut can be removed by the pincers. When this is done, a small piece of carborundum can be gently rubbed along the cut surface to finish it off.

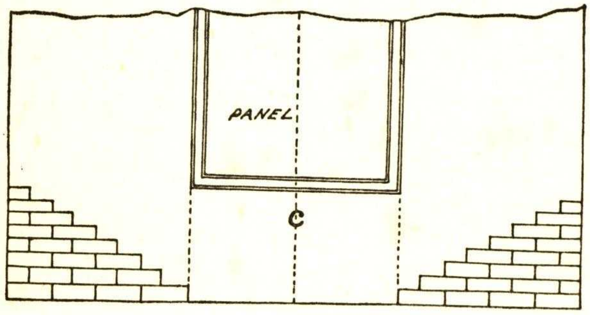


FIG. 142.

Fixing the Tiles.—The material used for fixing the tiles is generally a fine washed sand and Portland cement. Sometimes a little lime putty is added to it, to enable the tiler to work it better. A level horizontal chalk line should be struck for the purpose of fixing the first course exactly level. The method used for bedding tiles is to place the material on the back of the tile with the trowel; sufficient must be placed on the tile to form a solid bed between the tile and the cement screed. Tiles are laid sometimes to a line and sometimes levelled in on each course with a straight edge, which is placed on the top edges of them.

Figure 142 gives an illustration of two screeds of tiles which have been erected at either side of the panel. This is generally the method used, the remaining central portion being filled in and fixed with the aid of the line or straight edge. If the straight edge is used, it is placed against the two screeds and on the face of all the tiles along the courses as the work proceeds. These screeds are fixed before the centre part, and a plumb rule and bob is used to fix them in a vertical position. The panel is worked from the centre line for position, the height being generally given on the drawing which the tiler works to. The moulded vertical projections are plumbed in the same manner, and the horizontal parts worked in conjunction with them.

Types of Tiles.—There are many tiles on the market. Iron glazed tiles or sheets of tiles are sometimes fixed with screws. In the case of tiles which are placed in large stoves and kitcheners, they are screwed at the corners of the tiles. These screws are large flat-headed and hold the tiles firmly in position. A smaller tile is used for stoves, etc. These are sometimes fixed in the form of slabs, and are fixed in plaster. Tile surrounds are usually fixed on the surround after it has been formed, various shaped tiles and special curved tiles being used for this purpose. Opalite tiles are used extensively for bathrooms, etc. This is a kind of opaque glass about $\frac{1}{8}$ inch in thickness, consisting of a fine smooth glazed surface on the face, with small studded projections on the bed, which form a good key when the tiles are being fixed. These are generally fixed with Keene's cement or some light coloured material. Pantiles are also formed in glass as well as plain tiles. These are put in various positions in the roof where light is required.

Tiles Used in Conjunction with Arches and Lintels

Tiles of various kinds are used in connection with arches, lintels, arch keys, band courses, etc. Of late years these have been greatly used in various buildings and produce artistic and pleasing effects. Sand-face tiles have very generally been adopted either for forming the keys or the whole arch. Fig. 143 illustrates these tiles used in building the whole of the elliptical opening, and also the keys. The tiles in this case are bedded in cement and sand and finished with a flushed joint. Another method is to rake out the whole of the joint, and leave them in that condition. A third way is to finish the joints, or point them, with a neat finished smooth weather joint. The first method stated undoubtedly gives the best effect. The flush joints finished with a rough flushed surface match the roughness and texture of the sand-face tiles. The second method comes next in favour, for when the joints are raked out, the tiles stand out more in relation to their texture, etc., than when surrounded by the joint. The last-named method gives too much of the mechanical effect with the straight smooth surfaces of the cement joint between the tiles. It is a contrast to the first, where the rough finish of the joint lends itself to the rough artistic finish of the sand-face tiles. The elliptical arch can be formed also in Old English Red bricks and tiled keys or tiled arch and brick keys. Both styles look very effective.

Other tiles are also used with effect, such as a glazed tile of various colours. Fig. 144 illustrates the bull's-eye or wheel arch formed with these tiles which are thicker than the sand-face tiles, and also in various colours ; say, for instance, a red tile for the arch and green for the keys. These look very well, especially if glazed tiles are used. Then, again, the arch as in the previous case can be constructed with Old English Reds and the keys formed in tiles, or *vice versa*.

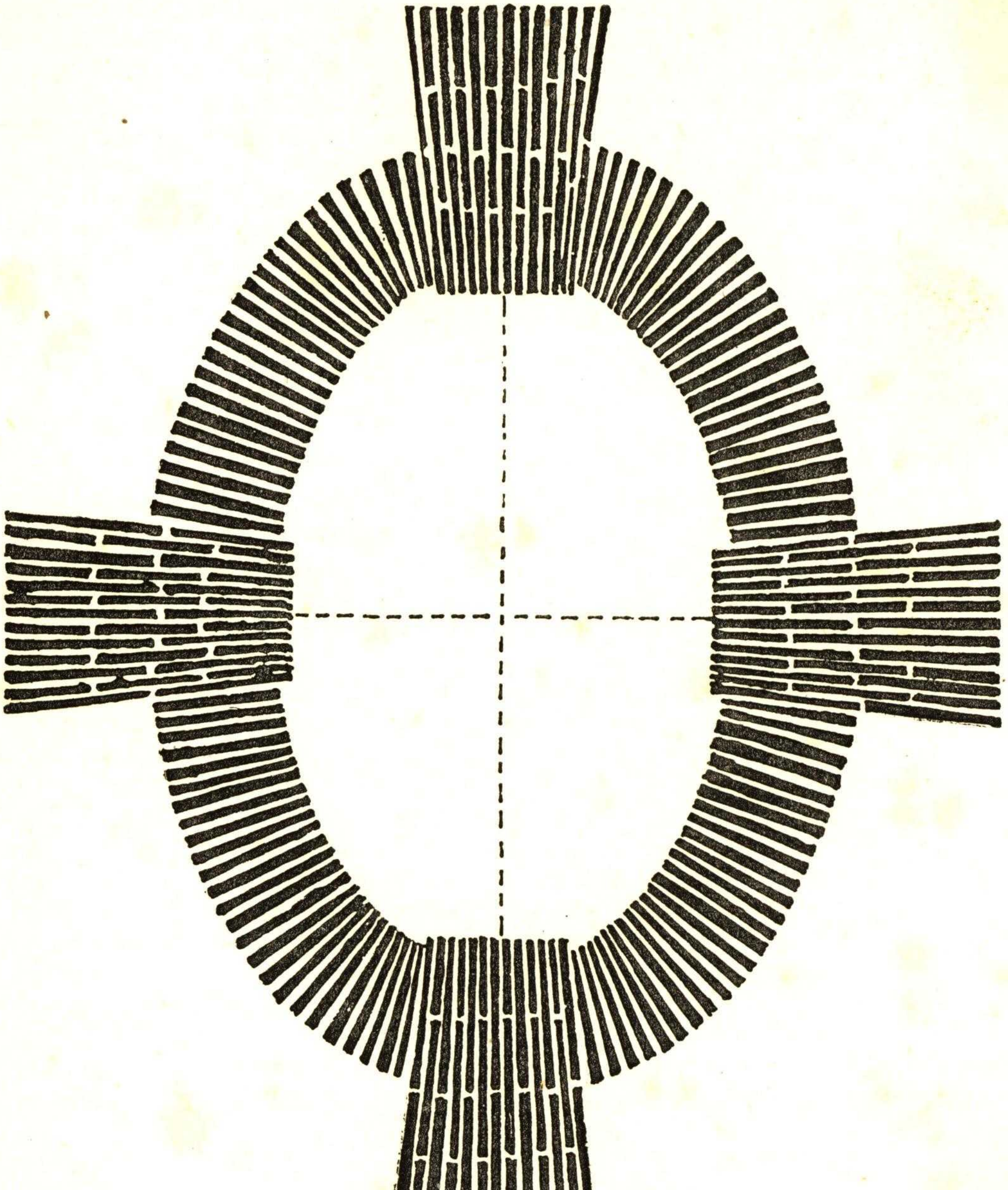
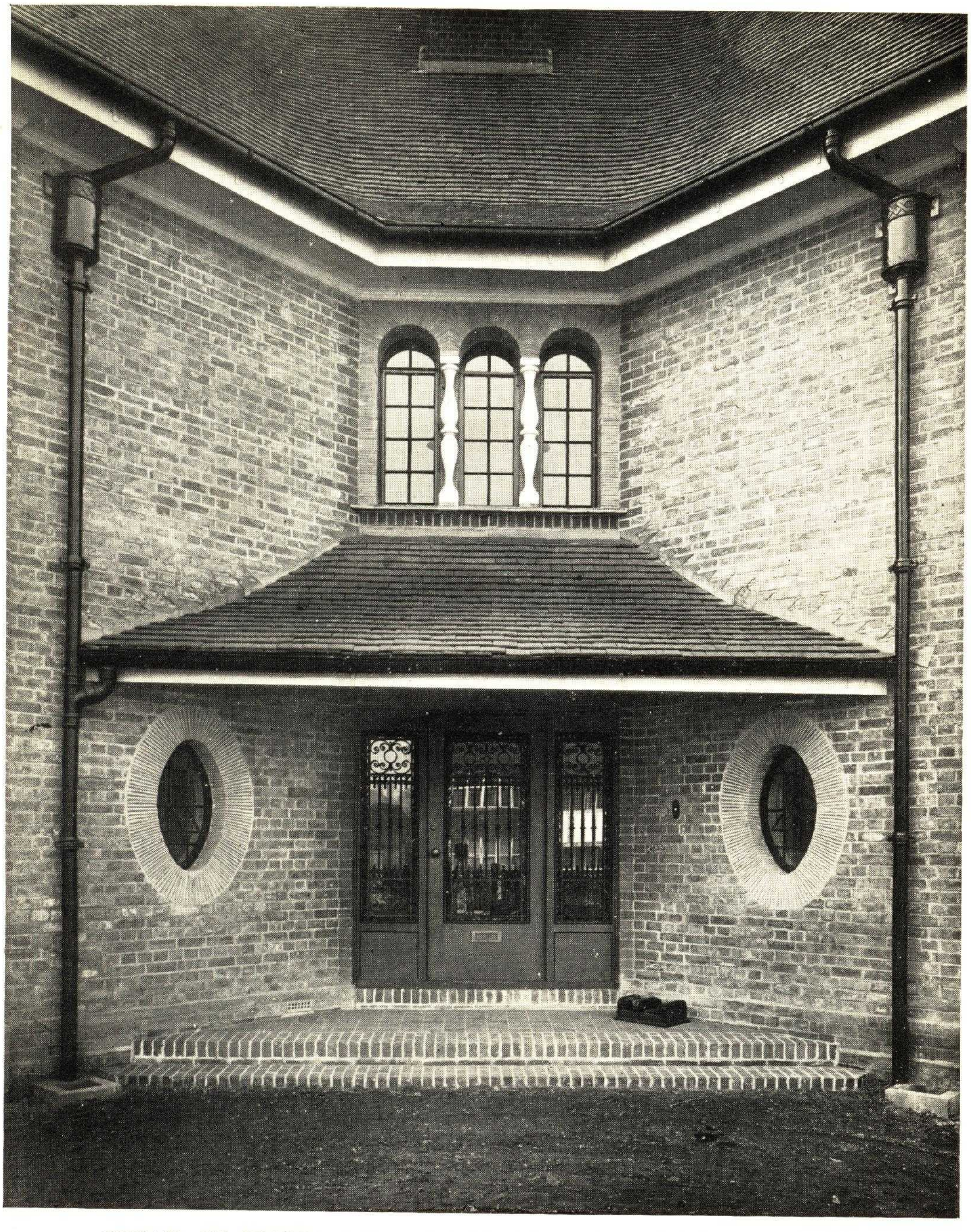


FIG. 143



DETAIL OF BRICKWORK, ENTRANCE TO COPSE HOUSE, SURBITON.
Joseph Hill, F.R.I.B.A., M.I.Struct.E., Architect.

Fig. 145 shows another form of arch which can be formed with tiles. Here the whole of the arch is formed in tiles, including a drop key in the centre with a head formed in small pieces of tiles. This arch would also look very effective with the arch formed in bricks and the key in tiles, or the key formed in brick and the arch in tiles.

Fig. 146 shows an arrangement of tiles bedded in cement and sand which forms a lintel over a doorway. This form of lintel can be precast and fixed in position when sufficiently set, or it can be formed on another lintel composed of iron. This illustration shows an iron strip across the opening for the purpose of constructing the tiled lintel upon. These lintels are sometimes reinforced by longitudinal bars, when the lintel is made *in*

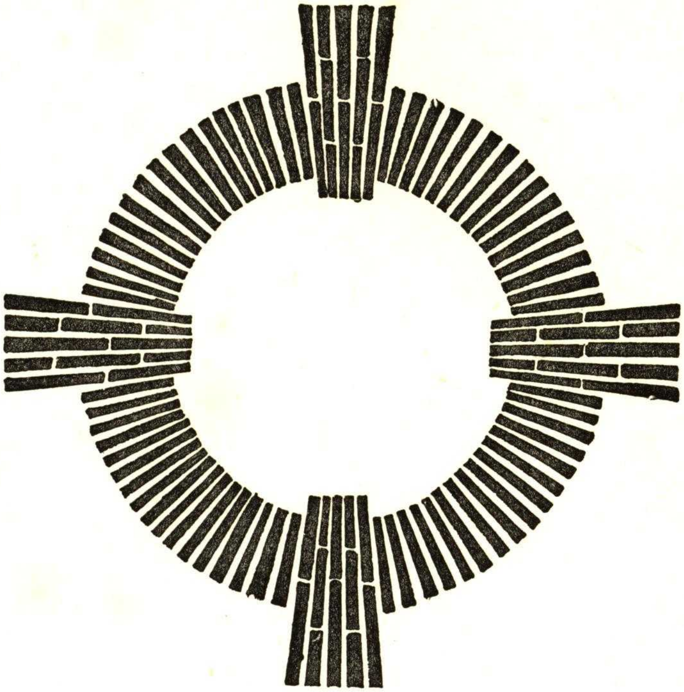


Fig. 144.

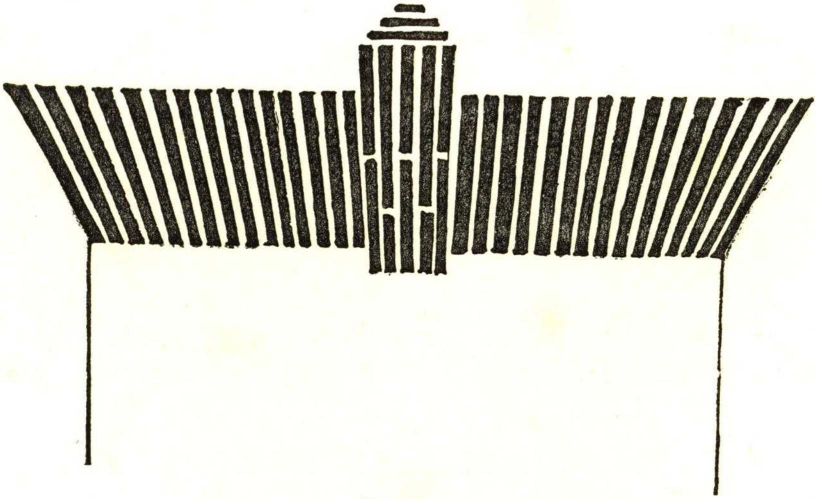


Fig. 145.

situ. Band or string courses round buildings can also be formed in various designs. Ventilators and air bricks can be made to look very effective by using different patterns formed with tiles (sand-faced, Broxby and others).

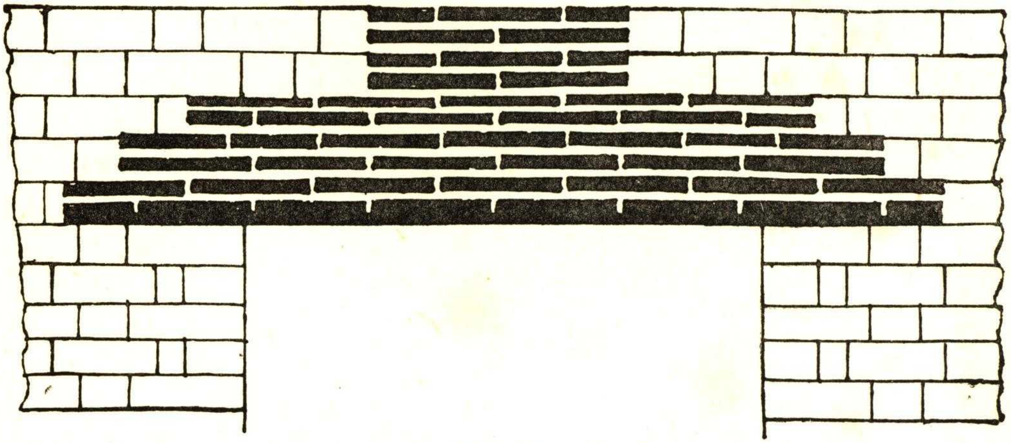


FIG. 146.

The illustration (Fig. 147) shows six patterns which I have designed from time to time and used on buildings.

TILE DATA

Plain Tiles.—10½ inches by 6½ inches by ½ inch, weight 2½ lb. each. Plain tiles, when laid with 3½ inches lap and 3½ inches gauge, require 633 tiles per square and 340 foot run of batten, and require 1,266 pegs at 2 pegs per tile.

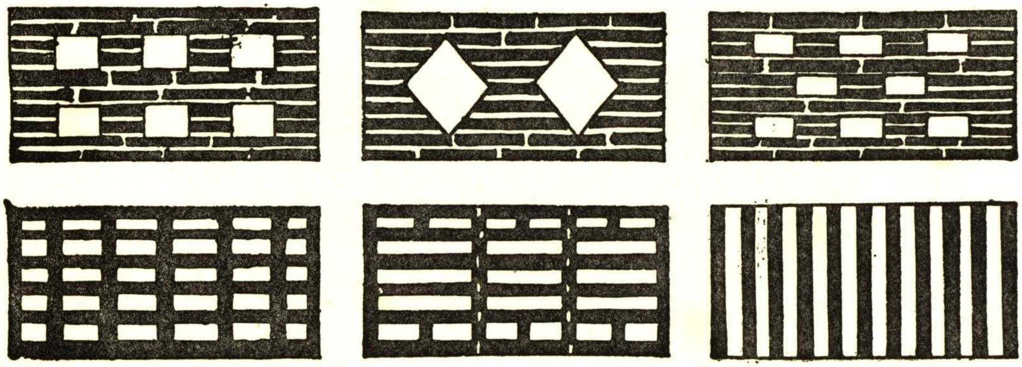
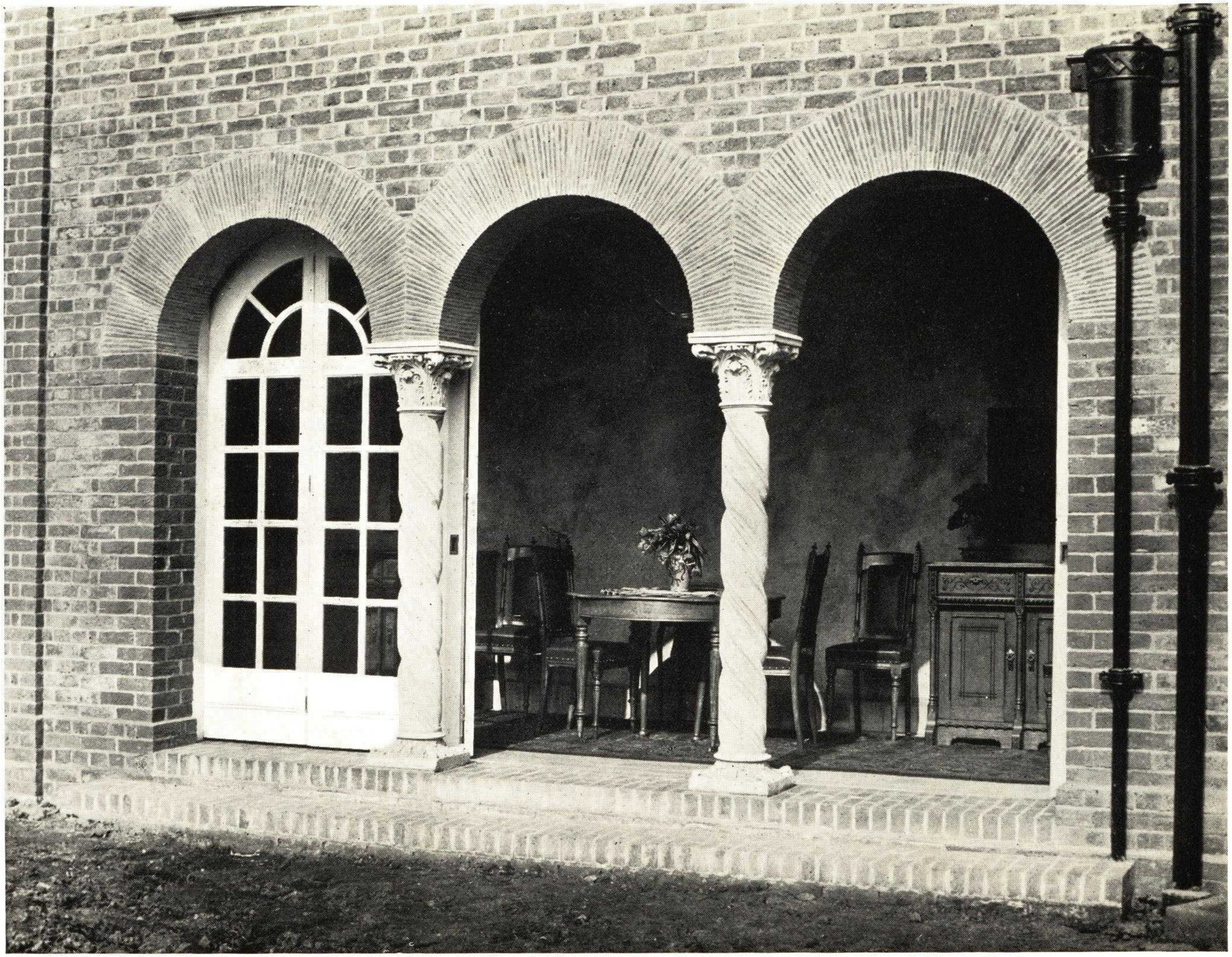


FIG. 147.

Plain tiles when laid with 4½ inches lap and 3 inches gauge require 739 tiles to the square and 400 foot run of batten and 1,478 pegs at 2 pegs per tile.



BRICK AND TILE WORK, COPSE HOUSE, SURBITON, VIEW OF BREAKFAST LOGGIA.
Joseph Hill, F.R.I.B.A., M.I.Struct.E., Architect.

Pantiles 13½ inches by 9½ inches by ½ inch weigh 5 lb. each; if laid to 10 inches gauge require 180 to the square; if laid to 11 inches gauge require 164 to the square; if laid to 12 inches gauge require 150 to the square.

Broomhall Tiles.—These are generally 12½ inches by 9½ inches and weigh 4½ lb. each; if laid to a 3½ inches lap and 9 inches gauge require 182 tiles to the square. These require patent pegs and nails.

The roofing tiles generally used in London are plain and ornamental tiles. Large supplies come from Shropshire (the so-called Broseley tiles).

Paving Tiles.—(1) Squares, 6 inches by 6 inches, thickness, 1 inch, 19¼ cwt. per square.

(2) 9¾ inches by 9¾ inches, thickness 1 inch, 50 cwt. per square.

(3) 11¾ inches by 11¾ inches, 1½ inches thickness, 111 cwt. per square.

(4) Hexagons, 6 inches by 6 inches, ⅞ inch thick, 14½ cwt. per square.

(5) 6 inches by 6 inches, 1 inch thick, 16½ cwt. per square.

(6) Octagons, 6 inches by 6 inches by 1 inch, 25 cwt. per square.

(7) Paving quarries, 9 inches by 4½ inches, 1¾ inches thick, 14 cwt. per square.

CHAPTER XIV

FLOOR TILING AND BRICK PAVING

Floor Tiling—Screeds—Laying the Tiles—Fancy Tiles—Borders—Cutting Tiles—Buckling of Floors—Expansion Joints—Brick Paving—Paving Yards—Paths—Street Paving—Tile and Brick Paving Data.

In Chapter I, Volume I, particulars have been given of the many varieties of tiles used for tiling corridors, halls, bathrooms, steps, forecourts, etc., usually made in thicknesses ranging from ½ inch to 1¼ inches, the large and thicker, buff, red, or blue quarries used in paving kitchens, sculleries, dairies, pathways, and the special bricks made for paving work. All these require careful handling if good, lasting work is to be done.

FLOOR TILING

Screeds.—For all descriptions of tiled floors, the essential point is the preparation of the screed or bed to which the tiles have to be cemented. As a rule, a mortar of cement and fine sand is employed, the thickness of the bed being prescribed by the specification, based on the nature of the flooring, the tiles, and the traffic to which the paving is to be exposed.

The usual method is to lay perfectly level the screed on which the tiles are to be placed, if the floor is to be laid in a horizontally level position. If laid to an incline, as sometimes is the case, the screed should be laid exactly to the required incline. When laying the screed for a large floor the levels are first taken, and sometimes marked on the side of the walls with a chalk line. Plasterers' screeds, or fillets, of cement and sand, about 3 inches in width, are then laid round the internal angles of the wall and floor. If the floor is of a considerable area, similar cross screeds are laid and bays formed. These are levelled from the first screeds. The intermediate spaces or bays are then filled in, and the whole forms one large surface for the tiles. The tiles are laid on this surface. In all cases, of course, the screed must be laid on a solid, level foundation, usually of concrete.

Laying the Tiles.—The usual method is to start from a centre line and work towards all the walls. In laying tiles by this method, a centre line is stretched along the centre of the floor, and the tiles placed in position; that is to say, the centre of the tile should be laid to the centre line. If the 6 inches by 6 inches quarry tile is used, 3 inches of the tiles should be shown at each side of the centre line. These tiles are sometimes laid in a square pattern, and sometimes are laid to a diamond shape. They look very effective if mixed, that is, if red and buff are used, or red and blue. The tiles can also be laid in screeds of tiles, working the bays between the screeds with a straight edge, about 5 feet in length. When all the tiles are in their correct position they can be grouted in with a thin grout cement. When sufficiently dry they should be wiped off and thoroughly cleaned with clean water to remove all cement stains, etc., from their face surfaces. When dry the floors are sometimes oiled over. This tones them down to a good colour. Sometimes the tiles are laid so that $\frac{1}{8}$ inch is shown on the face. These joints can be carefully pointed in neat cement, which is very effective, though a recessed rounded joint looks very well, and shows up the arrises of the tiles more efficiently.

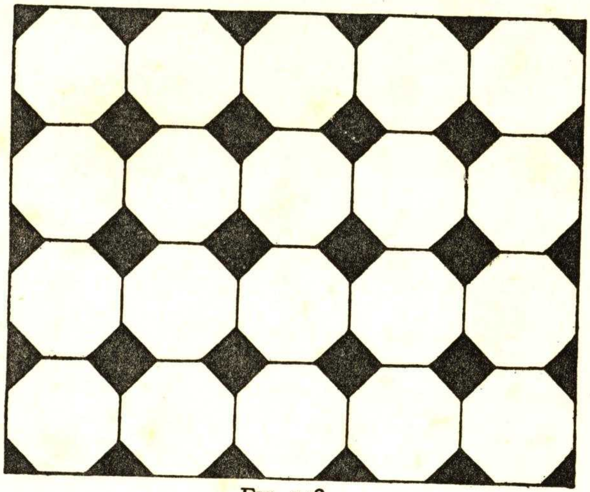


FIG. 148.

The tiling of forecourts and halls is carried out by the same method of screeding and grouting, and also finishing.

Fig. 148 shows a pattern used for the tiling of halls and forecourts, in which octagon-shaped and square-shaped tiles are used. These can be laid in a way to emphasise pattern by the use of various colours, black and white, buff and red, or buff and blue. This pattern has a very effective appearance when finished.

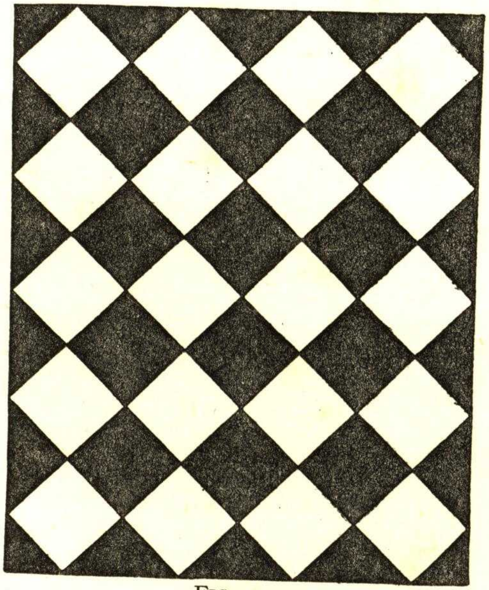


FIG. 149.

Fig. 149 shows another pattern in which square tiles are used. They can be laid also in the draughtboard pattern, or as shown, in the diamond pattern. These tiles laid in this design also look very well in a variety of colours, black and white, buff and red, or buff and blue.

Fig. 150 gives another two patterns for step tiling, one shown at each half of the step. These can also be laid in a variety of patterns to suit the surroundings and taste.

Fancy Tiles.—Tiles are not only made in different shapes, square, oblong, diamond, triangle, and polygon, but are also decorated with designs in colours. With the first, the tiler can work out his own pattern, suiting to the size of the space to be covered, locality, etc. But often the architect, or the tile maker or merchant, will supply a pattern sheet, and this is almost invariably done when decorated tiles are used. The tiler must then sort out his tiles and lay them strictly according to the drawing or plan supplied.

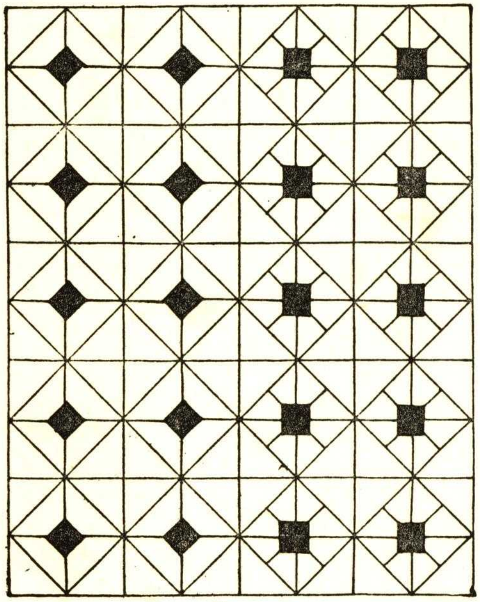


FIG. 150.

Borders.—With set patterns given above, and also with the more pictorial designs, it is sometimes found that the whole space to be covered is not filled out. This is sometimes got over by cutting tiles to complete the filling, but as a rule it is better to lay plain or ornamental borders, thus, as it were, setting the pattern within a frame. This not only produces a better appearance, but also enables the tiler to do without cutting, as half tiles are obtainable for adjustments.

Cutting Tiles.—Cutting unglazed tiles is not much more difficult than cutting bricks. A line should be drawn on the face with a sharp instrument, so as to make an incised cut without splintering. It can then be safely cut from the back, either with a sharp trowel or a chisel and mallet. With glazed, and particularly patterned tiles, the operation is far more hazardous. The face incised line must be firmly, sharply, yet carefully drawn, pressing the instrument steadily so as to prevent splintering. This operation should be avoided whenever possible, using the appropriate half and small fill-up tiles instead.

Buckling of Floors.—Trouble occasionally arises from the buckling of tiled floors, usually two or three months after being laid. The phenomenon is particularly pronounced where the floor is directly over, or influenced by, some form of central heating. In all cases this buckling is due to shrinkage of the concrete bed during the process of maturing. Where concrete floors are exceptionally thick, or are specially liable to be influenced by heat or damp, ample time should be allowed for drying, probably twelve months, before laying the tiles permanently.

This applies generally, but with particular force in decorative tile work.

Expansion Joints.—A useful precautionary measure is to lay a band of plastic mastic round the floor, to act as an expansion joint, which after a year can be cut out to make room for a band of tiling.

PAVING YARDS, ETC.—BRICK PAVING

Yards, stables, cowsheds, piggeries, etc., are often paved with special paving bricks, such as blue Staffordshire, Dutch clinkers, and "Adamantine." They are procurable plain and grooved, and also in appropriate moulded channels, etc. For such work the bricks, which should be previously well soaked, are grouted with cement mortar, laid on a bed of mortar on a concrete foundation. They are usually laid flat, but sometimes on edge, many bonds being used, though the herring-bone and zigzag patterns are favourites.

Paths.—Hard and ordinary red bricks make excellent paving for garden paths, forecourts, etc. Mr. Gilbert Jenkins, F.R.I.B.A., writes: "For cottages and small houses with tiled roofs, brick paths are very effective up to four or five feet wide, and all sorts of larks may be played with the pattern in laying them. In Holland, whole streets and quays are often paved with bricks; in fact, it is the standard material in most of the towns. The bricks are small in size, and are laid on edge in sand; there is thus a sense of scale. . . . If the house is tiled, a considerable number of tiles will be broken in transit to the site and during the work; if collected, the pieces may make a jolly centre paved in the forecourt, or even be used as a lacing course in building the garden boundary wall, and thus form the basis of effects novel to the general public." Such broken tiles, like the old English tiles, must, of course, be set in a good cement mortar.

Bricks may be laid on edge (half bond) or flat, in ordinary bonds, zigzag, diagonal, or herring-bone. For good, permanent work, there should be a foundation of concrete, finished flat or with the desired rough surface; but for light work, a foundation of broken stones, bricks, etc., well stamped down, will do. Over this a cushion of sand is laid, and the bricks pressed down on this, and then grouted with a cement lorry.

Street Paving.—In the United States, where bricks are used for street paving even more extensively than in Holland, fireclay pressed bricks, with a water absorption of 1·50, and shale wire cut bricks, with a water absorption of 1·39, are favourites. A common method adopted is to have a foundation of 1 : 3 : 7 concrete (the thickness of the bed depending upon the nature and the heaviness of the traffic), on which a two-inch cushion of fine sand is laid. The bricks are bedded in this, laid in straight courses at right angles to the kerb, set in a mortar of equal parts of Portland cement and fine sand, gauged sufficiently fluid to flow freely. This is swept over the surface of the not too closely packed bricks. When dry, a second dressing of the same grout, but of the thickness of cream, is squeegeed over the pavement with a rubber squeegee.

In England, an interesting and successful experiment was tried on the East Ham by-pass road, near the Royal Albert Docks, where two sections, about 100 yards long each, by 8 yards wide, were laid with Staffordshire blue bricks. Half the first section was laid on a bed of cement mortar ½ inch thick. Bricks were set by buttering one end and one face with the cement mortar, and laying with joints similar to those of ordinary brickwork. The second half was laid on a dry sand and cement bed, the bricks being set close and grouted with a one to one grouting. The second section was ordinary pavior's work, which was easier and cheaper. These sections were laid in May 1920, and in April 1929 they are found to be in good condition, though the road is used for heavy commercial traffic, with heavy loads at high speed. The experts of the Ministry of Transport reported that these brick pavings compared well with the other materials used.

In Ohio, U.S.A., where the winter ground surface temperature often falls below zero, rising to over 100° F. in summer, good brick roadways are maintained cheaply, which are dustless, resist suction from heavy motor traffic, and preserve excellent surface. To attain this, special attention is paid to support of the bricks, and to the use of an appropriate "filler" or jointing. The Highway Authorities say that the essentials are (1) to seal the joints against percolation of water; (2) to support the edges and corners of the brick; (3) to completely fill the joints; (4) to allow for both contraction and expansion. For general work, with comparatively light traffic and well-made bricks, a cement grout filling, not too rich, answers well, giving support to the bricks. But with rough, hard bricks, on roads subject to heavy traffic, a mastic filling of sand and bituminous materials proves best. There should be expansion joints every 50 feet. Bitumen provides a more satisfactory expansion joint, as it easily adjusts itself, but cement is apt to cause longitudinal cracks, and so damage the bricks.

Tile and Brick Paving Data.—For paving a square yard 9 tiles, 12 inches by 12 inches, will be required, 13 of 10 inches by 10 inches, 36 of 6 inches by 6 inches, 81 of 4 inches by 4 inches, 144 of 3 inches by 3 inches, 72 of 6 inches by 2 inches. For paving a square yard with bricks laid flat: stock bricks (9 inches by 4¼ inches by 1½ inches), 36 bricks; paving bricks, 36; Dutch clinkers (6¼ inches by 3 inches by 1½ inches), 70. Laid on edge: stocks, 45; paving, 85; Dutch clinkers, 146 (if laid herring-bone pattern, 136). There will be a slight variation over large surfaces, according to the width of the jointing allowed.

CHAPTER XV

OLD ENGLISH BRICKWORK

Sand-faced Multi-coloured Bricks—Bricks—Tiles—Gables—Arches—Quoins—Sundials—Panels—Chimney Stacks.

Bricks are now made in various Antique Multi-colours and shades, and surface textures which are also durable and at the same time present a very rustic and artistic appearance. These bricks can be obtained in the ordinary standard size, and also in various sizes and shapes for special arch work, panelling, façades, etc., in which an artistic appearance as well as durability in construction is required. The coloured frontispiece represents work carried out with bricks made by W. T. Lamb & Sons, Brick and Tile Manufacturers, of London. They show that a fine artistic finish can be obtained by using this class of brick. In this plate a warm rich finish has been obtained. Bricks of this colouring and texture, when properly blended and finished with the rough flushed joints, which harmonise with the bricks, will look well whether used for plain or gauged work. These bricks are picked and blended especially to form an old artistic appearance. The joints in the brickwork, and also the method of laying the bricks, is very important and care in this direction must be observed in order to produce the desired effect, such as the old English type (as in Fig. 154). Various patterns can be worked in the bond, one way being by introducing dark or black headers in order to form various patterns in the brickwork, as seen in some old Tudor, Jacobean, and Georgian work.

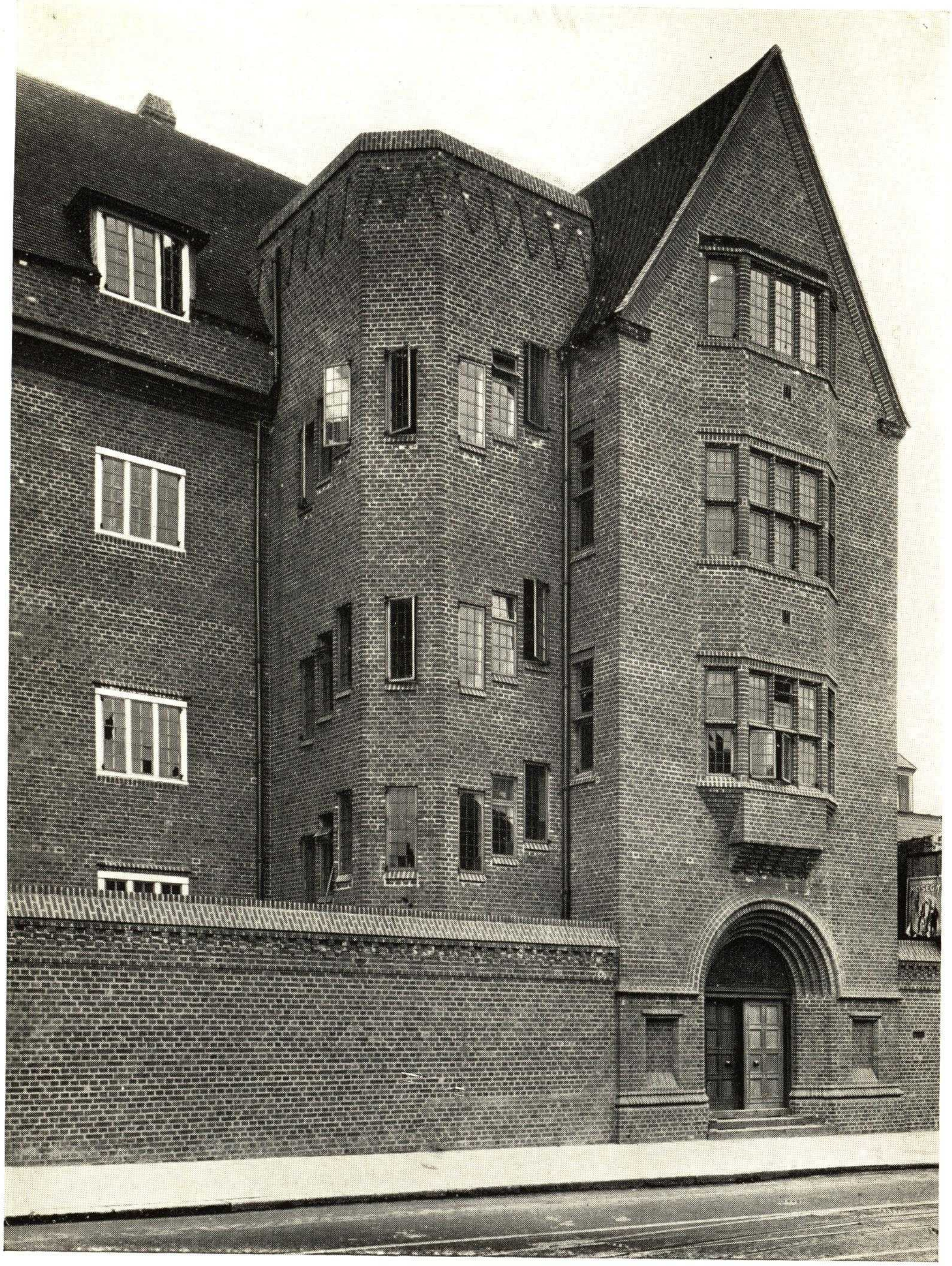
Unfortunately the countryside is very much disfigured nowadays by houses built with bricks which are absolutely out of place in the surroundings, such as, with Fletton bricks. These are excellent bricks for internal work, but seem very much out of keeping when built in the country, for they have a rigid, mechanical effect about them, while they lack interest in texture and colour.

There are many other facing bricks made, such as the mottled grey, and other sand-face varieties. Briquettes are also made in a variety of shapes and sizes, and produced in Antique Multi-colours, and are used for fireplaces, panels, etc. A very good briquette, the size of which is 6 inches by 2 inches by 2 inches, and made in multi-colours, can be used to advantage in constructing various designs for fireplaces, etc. Tiles which are placed on the roof can materially detriment the artistic appearance of the house if the right shade and type are not used. Roofing tiles are now made with that beautiful old colouring tint which is necessary to add the finishing touch to a house built in Antique Multi-coloured bricks. Such tiles and bricks manufactured in these fine old colours and surface textures are produced by careful mixing of clays, and burning of the bricks, and also by using a special time-mellowed clay for the purpose. In constructing this type of old English brickwork, firstly, care must be taken to select the bricks so as to obtain the various surface shades and colouring; secondly, all bricks must be kept clean and no mortar allowed to disfigure the face of the bricks. When mortar is allowed to fall on the face of the bricks it affects their original colour and face texture. Thirdly, all the bricks should be bedded correctly and the bond studied. In bedding the bricks, just sufficient material should be placed in position for the bed, so that when the brick is placed upon it and pressed into position, it forms a full solid joint. The condition of the mortar should not be too soft so as to prevent the material from falling down the face of the wall when the bricklayer firmly presses the bricks into their positions. The bricklayer should be able to easily remove the surplus material pressed out from the bed joint, with the blade of the trowel. In doing this he should hold the blade of the trowel at right angles to the bed joint and pull the trowel towards him. This forms a good flush joint with a rough surface. The cross joints should be done in the same manner. No smooth trowel marks should show on the face of the joints as this spoils the effect which is required. Another way is, after the bricks have been solidly bedded and the surplus mortar removed with the trowel, a small piece of wood is drawn along the surface of the joints giving a full flush joint. However, I think the former method is the best and cleanest way; in the second method the bricklayer is liable to rub the surplus mortar which he takes from the joints on to the edges or face of the bricks.

Bricks and Tiles.—Many types of decorative brickwork can be built; a combination of bricks with coloured tiles and rich coloured sand-face tiles. Also various arches are constructed with these two materials, as well as quoins to buildings. Often the brickwork which forms the bases for sundials and various ornamental chimneys is constructed with these materials.

Gables.—Fig. 151 shows the method used in forming the projection or corbelling at the base of a gable end. Old English bricks combined with tiles will produce quite a good effect in this case, double courses of tiles being used for each of the projecting courses. Four courses of tiles are also shown flush with the wall, which form a string course under the brick on edge course. The courses of tiles forming the projecting courses are stepped back as shown at A and B.

Fig. 152 shows another form of finishing at the base angle of the gable. In this case the projecting courses are sailed over every single course, and finished with a straight vertical surface at the back. Four courses are also shown of tiles under the brick on edge finish. A horizontal



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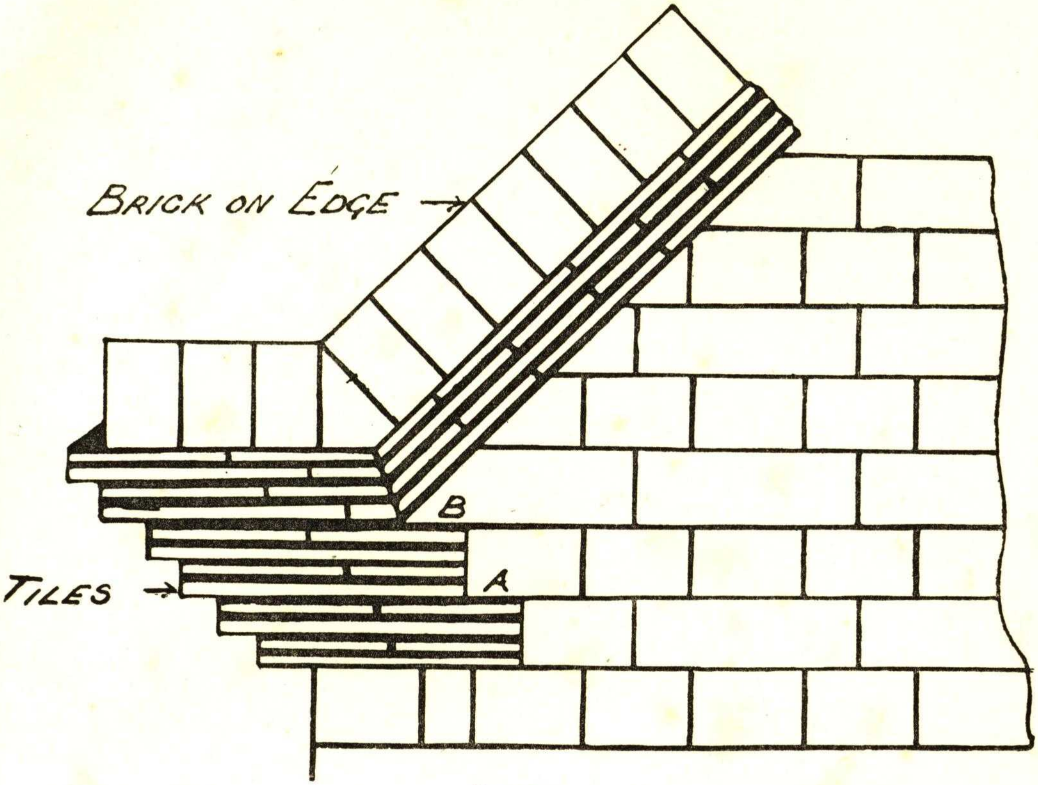


FIG. 151.

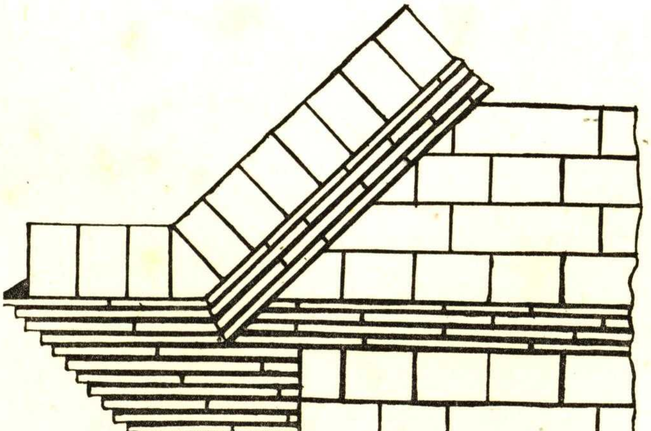


FIG. 152.

string course is also shown formed in four courses of tiles. The inclined string course under the brick on edge, and also the horizontal string course, which are both formed in tiles, can be treated differently. Instead of building them flush with the face of the brickwork, they can be built as projecting courses one over the other as shown at the end at A. These can be weathered at the top by a cement fillet from the edge of the tiles to the face of the brickwork. This also gives a good appearance when finished if a good class yellow stock is used, and sand-faced tiles used for the tile courses.

Arches.—Arches of various shapes can be built to look very effective if a good class of brick is used, such as Antique Multi-coloured brick, or the purple greys. Fig. 153 shows an arch built in order, which would look very well built with these bricks and finished with a full flushed joint. This arch is built in semi-circular rings, the number of rings being four. Each ring of the arch recedes back from the face of the brickwork. No. 1 ring shows in a line with the face of the external brickwork. Rings 2, 3, and 4 recede back from the face of the brickwork, each ring receding back a distance of $4\frac{1}{2}$ inches from the external face of the preceding ring of brickwork. The illustration at the bottom of this figure shows a plan of the side of the opening giving the set-backs in each ring of the arch. Arches are built in orders, with plain square jambs, or splayed jambs. In this form of arch the set-backs recede into the jambs at the springing points of the arches. The opening in this case is 3 feet in width.

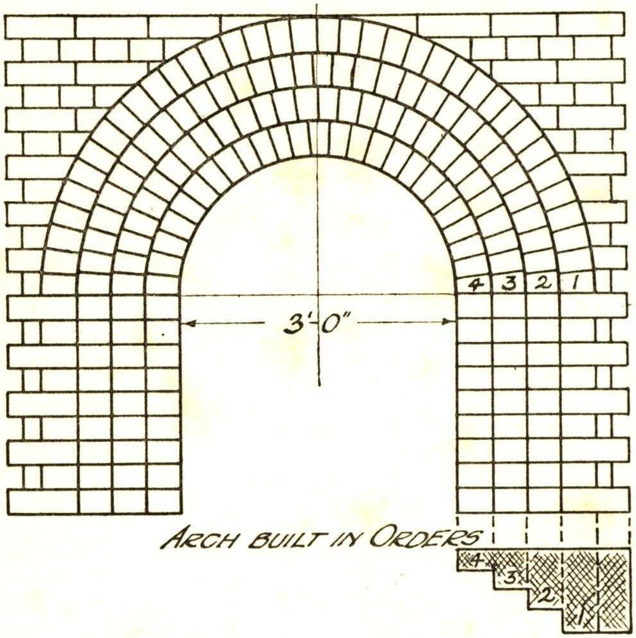


FIG. 153.

Quoins.—Quoins built in these bricks are also very effective. Fig. 154 gives an isometric view of a wall built in old English bond, with an indented block quoin. A wall of this description looks very effective if the face of the wall is built with good hard stocks, hand picked, and the blocks forming the projections at the corner of the wall built with mottled greys or old English sand-faced bricks. The stock work should be finished with a neat weather joint and the projecting blocks finished with a full flushed joint, left rough with the trowel to give it the rustic appearance. The method of drawing the isometric projection has been explained in a previous chapter on drawing. The projection blocks in this diagram are 9 inches or three courses in depth, and return from the corner point a distance of 13½ inches in each direction. The indent between each projection block is 3 inches, or one course of brickwork, in depth. This is built and formed in the same face as the wall which extends each way from the blocks.

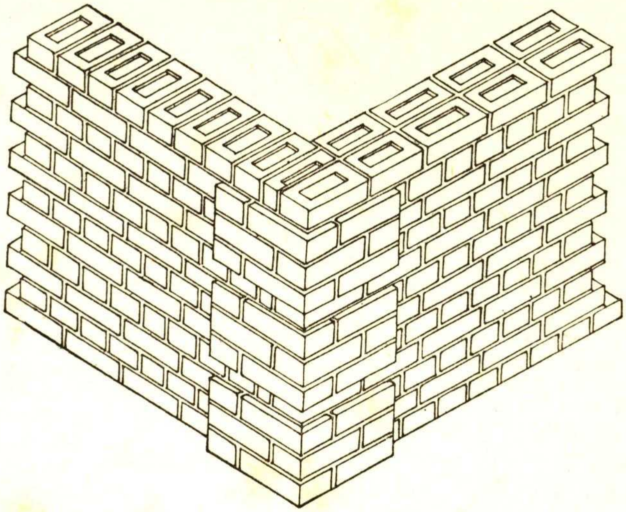


FIG. 154.

Fig. 155 shows an isometric projection of a 13½-inch wall with blocked quoins. A wall of this description would look very well if composed of old English red bricks with full flush joints. The blocks are 12 inches in depth and the face of the wall between them is also 12 inches in depth. The blocks return from the corner point each way for a distance of one and a half bricks. The bricks which compose the blocks are special purpose-made bricks, a little longer than the ordinary wall bricks, so as to give the projection as shown. The projection is about ¾ inch from the face of the wall. Fig. 156 shows another isometric projection of a 9-inch wall, built in Flemish bond, with a

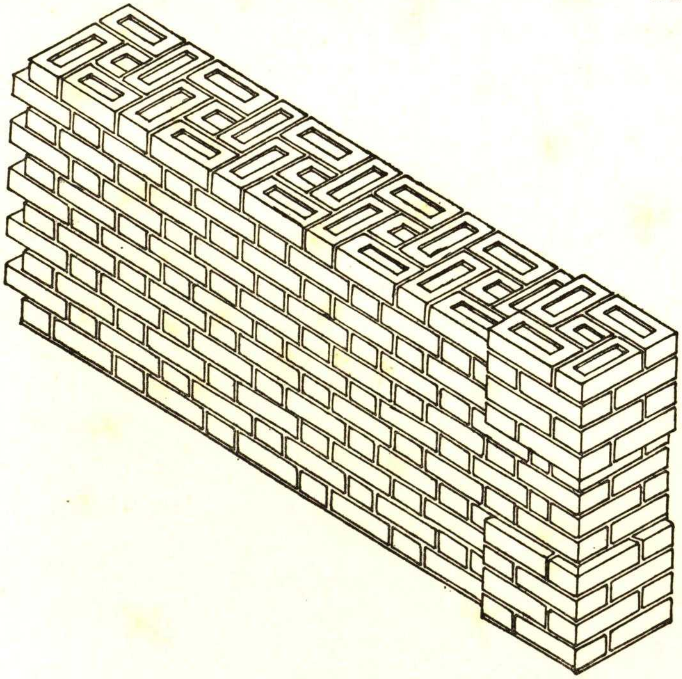


FIG. 155.

stopped end. The 9-inch wall is formed in old English reds and finished with a full flushed joint. The stopped end is composed of dark green glazed bricks. The glazed bricks form a series of blocks on the face of the wall. The first block being 12 inches by 14 inches, the second block sets back 4½ inches nearer to the quoin than the preceding one. Being 12 inches in depth and only 9 inches in width, the third block is the same size as the first, 14 inches by 12 inches. These blockings in glazed bricks finish with the same face as the old English bricks. The return of the glazed brickwork forms the corner point of a pier, 13½ inches in width, and also the reveal to a door opening, the frame of which is shown recessed back from the reveal face about 1½ inches. The glazed bricks are finished with a green-coloured joint to match the bricks. The old English reds and the green glazed bricks form rather a good combination in colour.

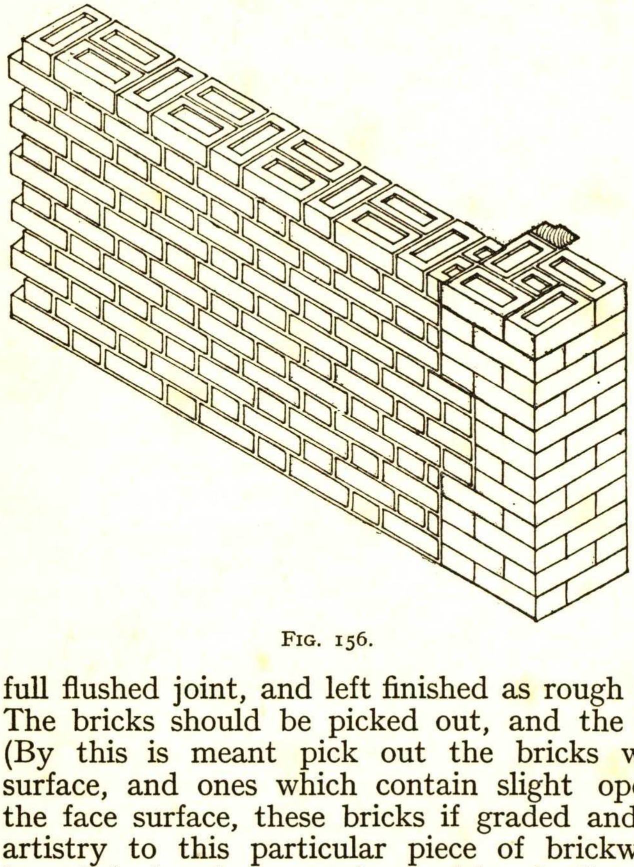


Fig. 156.

Sundials.—The base for a sundial built in a combination of old English red bricks and tiles is shown in Fig. 157. Various patterns in these two materials can be made. The base of the brickwork is formed in a square, measuring 18 inches by 18 inches, and built in old English red bricks, finished with a full flushed joint, and left finished as rough as possible on the surface. The bricks should be picked out, and the rough-surfaced ones used. (By this is meant pick out the bricks which show a very rough surface, and ones which contain slight openings in the texture of the face surface, these bricks if graded and placed properly will give artistry to this particular piece of brickwork.) On this 18 inches by 18 inches base rough sand-faced tiles are placed into position. Tiles with old colouring to be preferred to the bright red colour—the latter presenting more of a new effect, which is not required. These tiles are placed in a vertical position and each tile is cut to the shape of a triangle. These are bedded as shown with the inclined face of the triangle outwards. The inclined surface starts from the top edge of the 18 inches by 18 inches base and finishes at the base of the brickwork as shown above the tiles, the size of this brickwork being 9 inches by 9 inches. The beginning of the inclination of the tiles is shown at A, and the finishing point at B. These tiles should be bedded in their positions solidly, and care should be taken to keep the tiles as clean as possible. A pier 9 inches by 9 inches is then built upon the tiles when they have had reasonable time in which to set. This brickwork is built in the same style as in the base. On the top surface of this pier, two double courses of sand-faced tiles are bedded and fixed into position, the bottom double course of tiles projecting about ¾ inch from the face of the 9-inch pier on all four sides. The second double course of tiles also projects ¾ inch over the preceding course. A single course of chamfered bricks as shown is placed and bedded in position on the two double courses of tiles. The dotted lines as shown, which recede downwards from the top surface of this course, and also in a horizontal position, is a recess into which the plate of the sundial is bedded and fixed into position. Fig. 158 is an elevation of another pattern of a sundial base in brickwork and tiles in combination. In this instance the same kind of brick and tile is used and finished in the same manner as the former example. The base brickwork is in the form of a square, the size of which is 18 inches by 18 inches. Above this is built a pier the first course of which is 14 inches by 14 inches; it recedes inwards from the original base a distance of 2 inches on all four sides. From the second base, which is 14 inches by 14 inches, each course as it is built recedes from the preceding course inwards ½ inch on all four of its sides, until the height of ten courses has been built, and the size of the last course is 9 inches by 9 inches. Upon this last course three double courses of tiles are bedded into position, each double course oversailing a distance of 1½ inches. The dotted lines as shown, which recede from

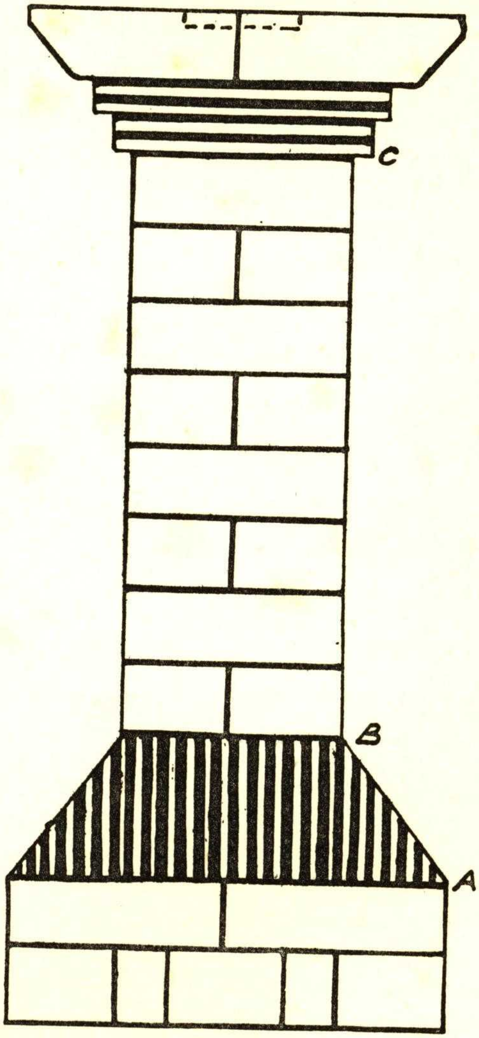


FIG. 157.

the top surface of the tiles, has already been explained in the former example.

Fig. 159 is another example of brickwork for a sundial. This form can either be built with purpose-made bricks or in gauge work. The base is 18 inches by 18 inches square, and upon this is bedded a course of moulded bricks. (These moulded bricks can be obtained from various manufacturers who always keep a variety of patterns in stock.) Another mould brick course is bedded in position above the preceding one. A pier of 9 inches by 9 inches is then built containing eight courses in all. Upon this is bedded another moulded course, finished with an oversailing plain course. A good deep red building brick, such as a Fareham red, is very suitable for this piece of brickwork. The moulded bricks can be obtained to match the plain bricks in colour. The tops of these constructions are sometimes weathered by spreading a layer of good cement and sand upon the top course, and inclining the surface of the cement to the outer edge of the brickwork.

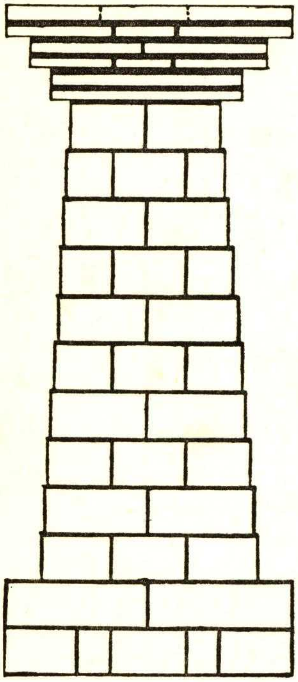


Fig. 158.

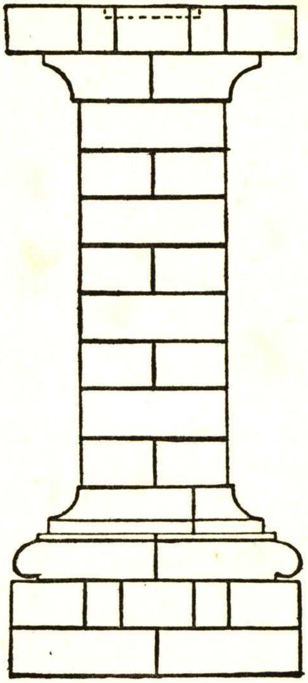


Fig. 159.

Panels.—Fig. 160 shows the elevation of another piece of brickwork, in the form of a panel, old English bricks and tiles being used in combination. The centre portion of brickwork, which is built in English bond, forms a recessed panel, placed or recessed back 4½ inches from the face of the main brickwork front. It should be composed of Antique Multi-coloured bricks, with full flushed rough surface joints. The square tiled panel in the centre should show the same face tile as the old English brickwork. The outside brick on edge should also be composed of the same kind of bricks as the recessed panel. Each of the corners is composed of tiles, cut to shapes as shown. These should show the same face as the brick on edge work. All the work should be kept as clean as possible, and especial care should be taken over all the joints to give them old rough artistic effect.

Fig. 161 shows another panel in old English bricks and tiles in combination. In this case the panel, built in old English bond, is recessed back 1½ inches. The bricks, which are built on their edge to form the border of the panelling, show the same face as that of the external brickwork. The tiled pattern in the centre of the panel in the form of a cross shows a projection from the face of the panel of 1½ inches, therefore showing the same face line as the bordering of the panel, which is the brick on edge. The brick on edge bordering is mitred at the angles. The internal angles of the cross pattern in tiles is mitred towards the centre point.

Fig. 162 gives another illustration of a panel. The panelling consists of bricks laid in diaper bond. This form of bonding looks very well if composed of

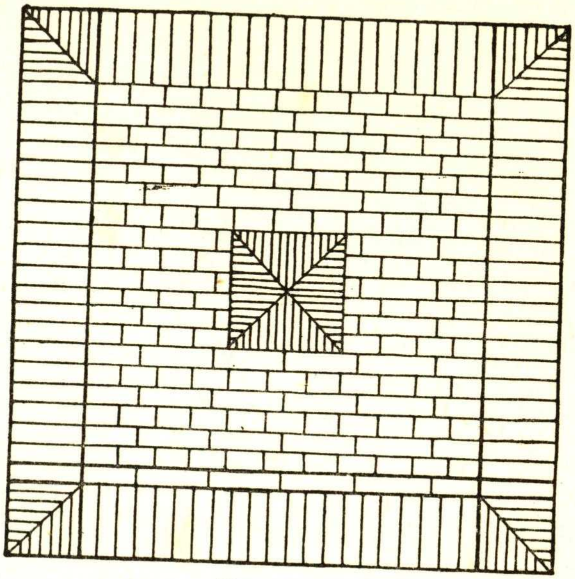


FIG. 160.

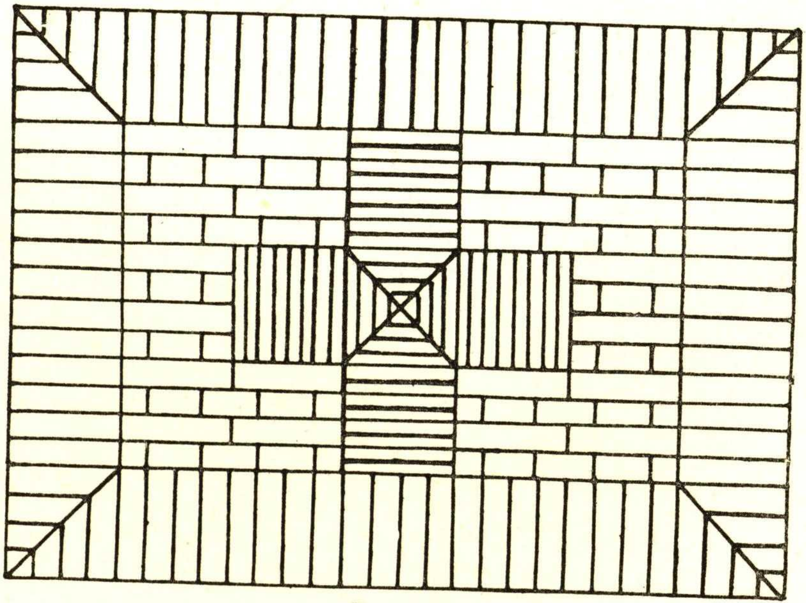


FIG. 161.

multi-coloured bricks of a special shape, now made 9 inches by 4½ inches by 2 inches, or briquettes could be used with equal effectiveness; the size of these is either 6 inches by 2 inches by 2 inches or 6 inches by 2 inches by 1 inch. Both these sizes are now made in Antique Multi-colours. The joints should again be the full flushed joints (finished rough surface). A border to the panel is composed entirely of tiles mitred at the angles. Instead of the joints being finished flush on the tiles, they can be raked out fairly deep and left in

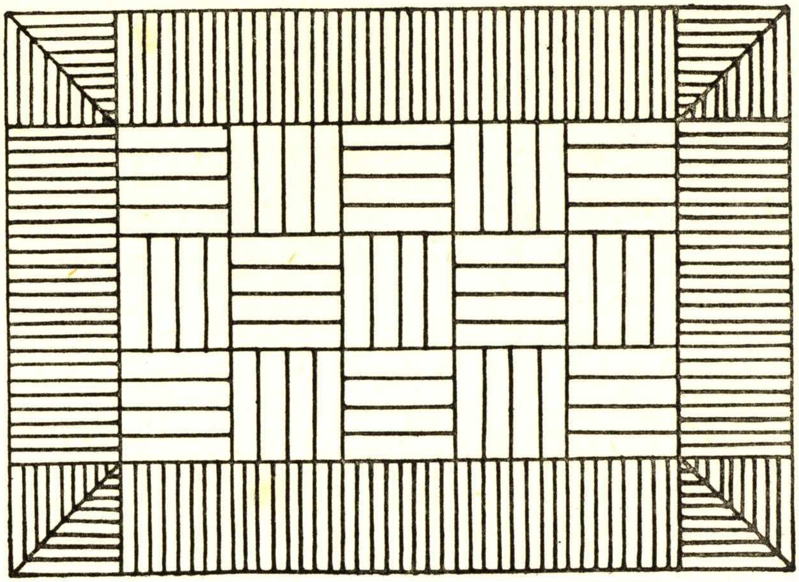


FIG. 162.

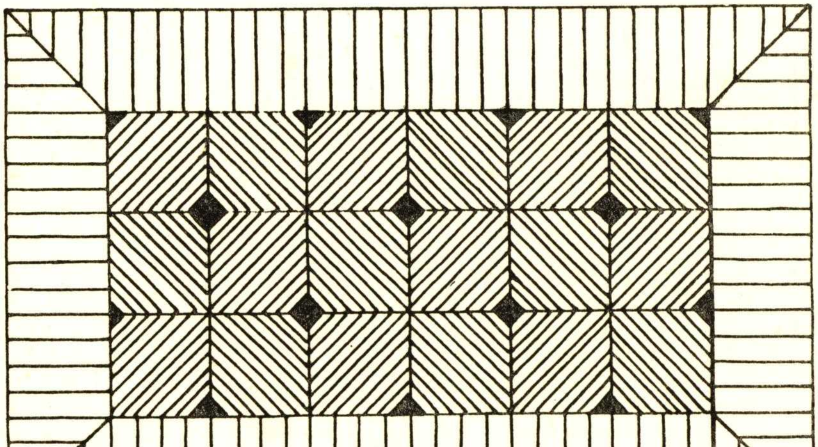


FIG. 163.

that condition. This panel can be built with the same face as the external brickwork, tiles and panelling included; or the same panel can be built with a 1½ inches projection from the face of the external wall. Both methods should prove effective.

Fig. 163 is an illustration of another form of panelling, the panel being wholly composed of tiles built in diagonal fashion, surrounded by a brick on edge, mitred at the external angles. This panel looks well if projected about 1½ inches from the external face of the wall, the tiles and also the brick on edge bordering showing the same face. Of course, there is a great deal of cutting required in relation to the tiles, but if done carefully a great deal of wastage can be saved. The border looks effective either in red bricks or the old English antique multi-coloured bricks. There are a good many patterns that can be arranged to combine these bricks and tiles, so as to obtain very artistic effects. I have designed these four patterns in order to show the many ways in which these materials can be arranged, in order to obtain an effective appearance. The small squares in the panelling can be filled in with the flushed joint or a small tile can be inserted to match the other tiles in the panel.

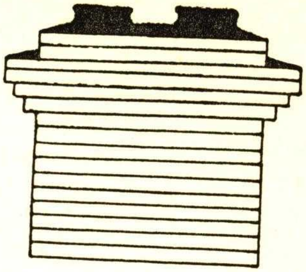


Fig. 164.

Chimney Stacks.—Artistic appearance of chimney stacks can be attained by the use of suitable bricks in combination with the design. Fig. 164 shows the elevation of a two-flue chimney stack with three oversailing courses. One vertical course is placed in position over the last oversailing course; two vertical courses are then set back to the perpendicular line of the original stack below the oversailing courses. Short pots are placed in position and flaunched in cement and sand to form weathering on the top of the stack. The top of the oversailing courses are also weathered in cement and sand in order to protect them. These short pots are of a much neater appearance than some of the tall pots one sees on some of the old stacks. Fig. 165 shows another form of chimney stack with short pots well flaunched in cement and sand in order to prevent the dampness penetrating in a downward direction into the stack. This form of stack presents a neat appearance when finished in good stock bricks or red bricks. There is only one oversailing of 1½ inches which finishes in the four top courses. These two illustrations of stacks present neat plain patterns which is all that is necessary in certain types of houses. Too many raking courses, oversailing courses, and also dentil and dog's toothing courses, are not necessary in this type of stack. Often such courses

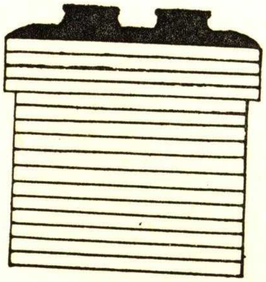


Fig. 165.

form projecting points round the stack and are subjected prominently to the elements and in the course of time, owing to bad weathering, give the stack a very bad appearance. This class of stack is sometimes rendered in cement and sand to cover up these defects caused by the weather and so the final touch of ugliness is completed. There is nothing more unsightly than to see a chimney stack covered over in this way, standing amongst other chimneys of a more presentable appearance.

Fig. 166 is an elevation of a different form of chimney stack which sometimes adds to the artistic amenities of its surroundings, or gives a touch of distinction if placed correctly in a building. I am now referring to a stack with a rectangular rising from the roof upon which the flues are grouped and set in a diagonal fashion on this rectangular base. This is either weathered in tiles or bricks in order to form the splay from the outer edge of the rectangular base, to the internal angles of the diagonal-shaped flues. This splay from the outer edge of the base to the internal angles is shown in the illustration by the black shading. The base has one oversailing of two courses in height. The plan in the illustration shows the position of the flues. The top portions of the two diagonal flues are finished with only one oversailing consisting of three courses in a vertical position. The bricks which form the last course of the diagonal flues should be weathered on the top surface to protect them from rain and snow.

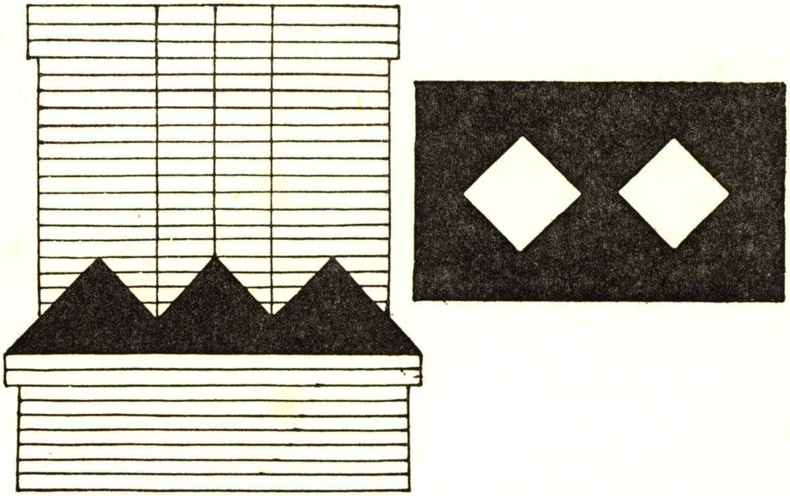


FIG. 166.

A template is sometimes made in order to work to the diagonal shapes of the flues, which is placed up the last base course, and the positions of the flues marked, before the construction is proceeded with. A stack of this description would look very effective if built with old English reds and finished with full flushed joints (left with a rough surface).

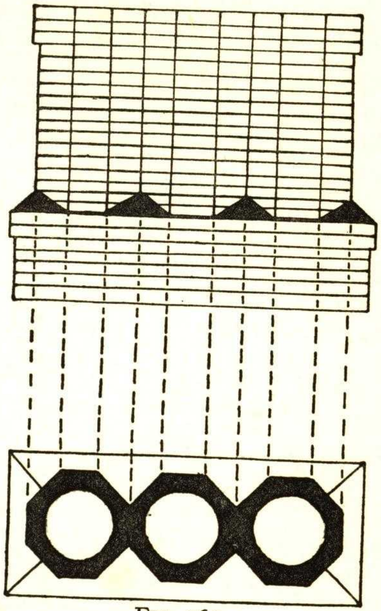


FIG. 167.

Fig. 167 is another illustration of a chimney stack which rises from a rectangular-shaped base from the surface of the roof, which has one oversailing part consisting of two vertical courses forming the top portion of the base. Upon this base are set out three flues, octagonal in shape, which are joined to each other. The top part of the brickwork of the octagonal flues is finished with one oversailing also consisting of two vertical courses, the same as the base oversailing. The top courses are weathered in cement and sand as usual. A splay is formed from the outer edge of the base to the sides of the octagonal-shaped brickwork which encases the flues. This is shown by the black shade in the elevation. The plan shows the positions of the brickwork and flues. The vertical dotted lines which project upwards from the plan to the elevation show the positions of the sides of the octagonal-shaped brickwork on the elevation. Each squint quoin point is shown on the elevation and indicated by a vertical line from the base to the top of the stack. I have seen this type of chimney built in a first-class malm brick, and it has quite an effective appearance. This type would also look well if built in old English reds and finished with a full flushed joint (rough finish). It is a type of stack which is sometimes built with a single flue.

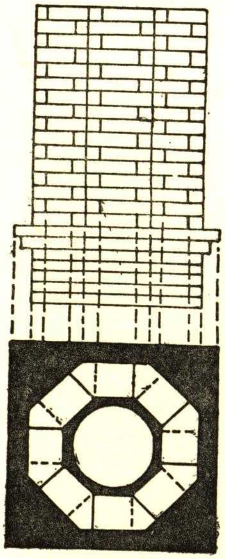


FIG. 168.

Fig. 168 is an illustration showing one of this type built as a single chimney. In this elevation the base is shown built with two oversailing courses as a finish of the base, the remaining portion of the elevation being built in the octagonal shape with no oversailing courses. The top course should be weathered as usual. The splay from the outer edge of the top course of the base is not shown in this elevation. The courses of brickwork are shown before the splay is put on the top of the base. The vertical dotted lines in the elevation again show the sides of the octagon-shaped brickwork which surrounds the flue, projected from the plan to the elevation. The plan shows the position of the flues, and the brickwork which surrounds them, and also the splayed surface from the outside face of the flue brickwork to the outside of the top course of the base. The bond of the bricks is also shown. The first course is indicated by plain lines and the second course by dotted lines, only squints being used in the construction—the face of the squint being about 6¾ inches and the return about 2¼ inches. This stack would look effective if built in old English reds and finished in the same method as in the case of the grouped octagonal stack.

Fig. 169 shows the elevation and plan of a spiral chimney. This type of chimney looks very effective, if built in old English reds with a full flushed joint, finished with rough surface, or the indent bricks built with dark reds and the projection bricks built with dark blues. This brings out the prominence of the projecting bricks.

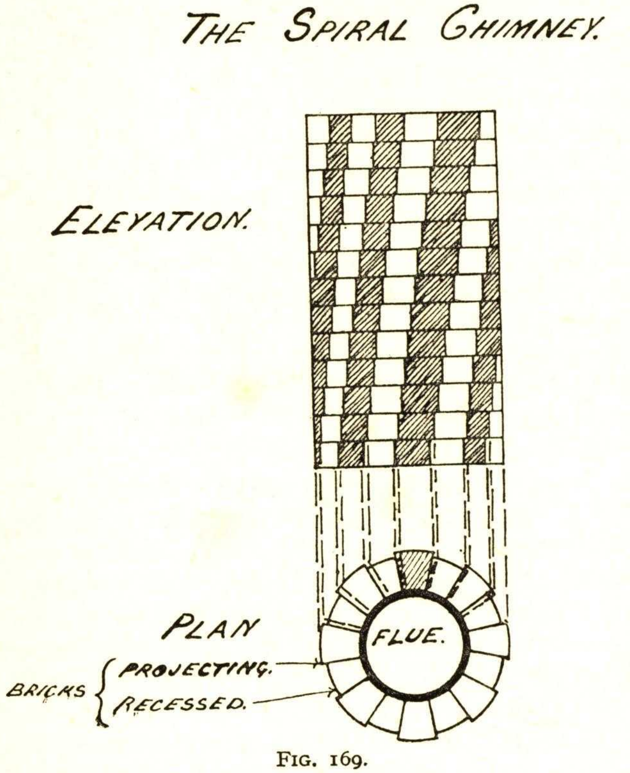


Fig. 169.

Fig. 170 shows the plan and elevation of a single spiral flue. These spiral chimneys are also built in groups of three and upwards, according to the number required on a stack. A represents a template or mould. This is generally used to set out the chimney at the base of the stack. The outside of this mould represents the outside face positions of the projection brick as indicated by arrow on plan. The inside of this mould or the inner circle represents the finished face of the flue lining. All materials which compose this chimney should be of a strong nature, on account of half bricks being used, which are necessary to form the required radius. All these half bricks have to be cut to a wedge shape, to allow for the radiating of all the joints to the centre of the flue. The joints should be composed of strong material and all be kept as uniform as possible. When all the half bricks have been cut, they should be placed in their positions, trying the mould or template on them. Having laid every other bat to the face of the mould and bedded same, the indented bats can then be laid in position and bedded. Their positions from the face of the projection bricks can be ascertained by the use of a small wooden gauge made with a rebate, to the required distance which is marked on it. This gauge can be tried each time one of the indented bats is bedded. By this method equal indents are obtained all round the chimney. Having bedded the first course of bats in its correct position (the first course of bats is shown on the plan and indicated by plain lines), the position of all the faces of the projection bricks should be marked on the outside of the template. The second course of half bricks should now be laid in which the spiral points of the projection bricks should be laid to the mould, by either moving them in a left hand or right hand direction from the original position of the first course. These points can be ascertained by moving the template ¾ inch round to the right beyond the end of each of the projection bricks. They then will be the new right hand points for the sides of the projection bricks. They can then be marked on the template, and the projection bricks laid to them. The indent bricks can then be laid between the projection bricks. Of course, the indent bricks are in a different position to the first course, but the same distance round to the right direction as the projection bricks. The spiral movement of the projection bricks can be marked on the template, each course to ensure regular distances being taken as the projections bricks are placed to the right. The vertical dotted lines, which are projected from the plan to the elevation, show the second course of the projection bricks moved from its original position in the first course to the right. The elevation shows each course moved a certain distance to the right beyond the preceding one. This measurement to the right can also be obtained by a small rebated gauge made for the purpose as well as the mould or template being used for the purpose.

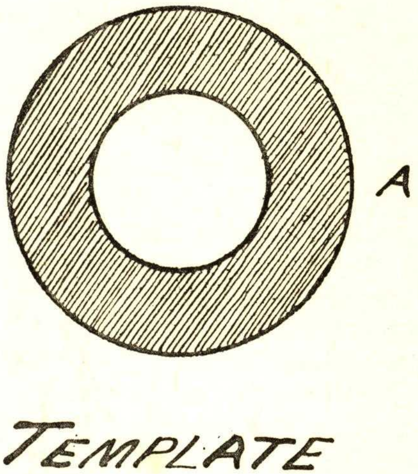


FIG. 170.

CHAPTER XVI

DECORATIVE BRICKWORK

Standard-sized Bricks—Colour—Panelling—String Courses—Varying Projection and Spiral Work—Variations in Chequers and Herring-bone Patterns—Raised Trellis Pattern—Gauged Work—Picture Making—A Novel Bond—A German Variation of Bond—Two-coloured Pointing—Stucco and Brick—Chimney-Stack and Garden Fountain—Open Brickwork Flower Boxes and Walling—Brickwork and Tile Hanging.

BRICKLAYING is a craft full of interest, for apart from the deftness which leads to a satisfactory number of bricks being placed in position within a given time, skill is needed to accomplish sound, handsome-looking work. That the handling of bricks can be carried to a pitch approaching fine art is proved by numerous examples from the fifteenth to the eighteenth century. There was a lapse in taste during the nineteenth century, but some of the modern work is excellent, showing that the cunning of our forbears has not been altogether lost.

The standardisation of bricks as regards size and quality was, no doubt, a great gain, but it did at first tend to give special prominence on the market to the Fletton type, which is not an ideal facing brick from the art standpoint. It is uninteresting in texture and poor in colour, which are characteristics of many of the machine-made bricks.

Now, one of the merits of brick as a building material is its diversity. By judicious selection of size, colour, texture, and surface treatment, it is possible to introduce striking variations to meet the requirements of any style, and any type of edifice. A leisurely stroll in that part of Westminster which lies between Victoria Station, the Houses of Parliament, and St. James's Park will reveal a good deal of fine brickwork, exemplifying many periods and methods of treatment, from the decorative style of Queen Anne's Gate to the stern simplicity of Westminster Cathedral.

Standard Sizes.—For ordinary walling there is everything to be said in favour of standard sizes, but for dwellings, public buildings, and decorative purposes generally, small sizes are a great acquisition, providing their proportions are such that with the aid of bats and closers a certain number of the smalls may be made even with the courses of average bricks. This variation is especially useful when building up panels, piers, or string courses. There are positions where a thin and particularly a short brick (something like a two-thirds bat) is an immense help in gaining the desired effect. This naturally means more expenditure of labour, but this can be minimised by using the smaller as facing bricks only.

Where a handsome appearance is aimed at, too much attention cannot be paid to the question of texture ; it certainly should be close and fairly even, but this need not exclude mottling and variations in the composition, if pitting, pockets of unburnt clay, or patches of half vitrified brick are excluded. From the artistic point of view, it is possible to have a texture so even that it has a dull effect. The sand-faced brick gets over this difficulty.

Colour.—Then there is colour. There is an almost endless choice here, ranging from white, through greys and yellows to reds, browns, and blacks, to which must be added the mottled. As a rule it is safest to build with one coloured brick only. But in careful hands a moderate admixture of colours is a legitimate means to give interest to an elevation and to bring out detail more prominently. Thus, we may say that a variation in the colour of brick is permissible as regards piers in their entirety, or for their bases and caps, also in string courses, quoins, corbels, and cornices, even arches over doorways and windows ; but scarcely for panelling and still less for carrying out patterns. Yet we find variations in colour most frequently introduced precisely when surfaces are decorated with patterns. On examination, however, it will be realised that this treatment always produces the impression of fussy patchiness and should be avoided, even in a villa.

Where surface patterns are introduced some differentiation is necessary, but this should be a matter of slightly stronger or lighter shade, or of texture, rather than distinctive coloration. Such patterns are of doubtful value, while they entail much time and care. Adornment is always more satisfactory when it indicates or suggests structural purpose. And this is not the case when we have stepped trellis pattern, diamond, and saltire, and such-like vagaries. It is otherwise when raking and fanning are employed, the latter partly attained by means of cutting the bricks and varying the thickness of the mortar joint. By this means strength is gained, and the work done will be sufficiently apparent if there is not the least difference in colour or type of brick. Chequer patterns, only in two colours, are useful for blank gable ends, or even on blank side walls.

PANELLING

Variations in bond, usually in the form of panels or bands, are legitimate enough, though unless the design is of the best and in keeping with the whole elevation, the extra cost in material and labour is scarcely worth while. Probably the best variation is the use of a raking bond, right or left herring-bone pattern, which may, indeed, serve a genuine structural purpose, as such a bond would add strength to a base, or introduced in bands would act as a lacing course, or in long vertical panels could be made to play the part of piers in sustaining loads. In such cases it is quite proper to choose for the raking bond a better-quality brick than that employed for the rest of the walling, because these panels or courses are serving a special purpose, the later reception and distribution of stresses. On the other hand, if the panels and courses do not really sustain extra loads, then the bricks used for them should be approximately of the same quality as the rest, otherwise they would probably prove a source of weakness.

Of purely decorative value, although having the appearance of structural purpose, is the use of sunk or raised panels. There can be no doubt that these when properly proportioned lend interest to a wall. A recessed panel should not be too deep, certainly not more than half a brick deep, preferably not more than one-third. This will necessitate careful adjustment of the bond, which is secured by introducing closers behind the surfacing bricks. These closers should be used in the least wide part of the walling, whether this be the panelling or the piers.

Raised panels are treated in the same way for adjustment, though the bricks forming the panel are stepped forward as in corbelling.

Sometimes the panels have sharp arrises at the edges ; more often they are rebated or otherwise rounded off. This can be done by rubbing, or purpose-made bricks can be used.

Often the panels are merely formed by means of mouldings. In the simplest type it is merely a question of forming with a differently coloured brick. In more elaborate work the moulding projects, and may be carried with ordinary bricks stepped forward with closers behind, or with purpose-made bricks or terra-cotta. If ordinary bricks are used, the upper edges at least should be rounded off in a curve.

String Courses

String courses may serve both a structural and decorative purpose ; the former when the bricks so used are of a harder nature than those for the rest of the walling (possibly to form beds for floor beams or roof joists) ; the latter when the brick is of a different colour or texture. String courses are also frequently made to project, and if of large size may be decoratively carved. Purpose-made bricks and terra-cotta are used for the same purpose.

A variation of the above is seen when the horizontal string courses are used in combination with vertical bands, whether flush (with differently coloured bricks) or projecting. We may have a pale brick for the general walling, with darker-hued brick for quoins, string courses, and framing for windows and doors. A pleasing effect is gained and useful purpose served if the framing over doors and windows is given outer projection, possibly by corbelling, so as to provide drip-stones or canopies.

As already stated, horizontally projecting courses should always be weathered, but the rounding off of edges on vertical projections is not necessary.

CORBELLING AND TILE CREASING

Corbelling and tile creasing, which also serve the dual functions of constructive utility and decoration, are dealt with at length in other chapters of this book.

VARYING PROJECTION AND SPIRAL WORK

Byzantine brickwork on the Continent and Tudor work at home are much admired, especially in turret, chimney stack, and pillar construction. Wonderfully good artistic effects were obtained by simple enough means and without loss of structural security. An endless succession of patterns was produced by means of varying projection, laying bricks at angles, introducing corbelling and bracketing. The style is once more in favour for high-class work, and the old methods are being reintroduced.

Except where bricks were set at angles, projecting courses were generally, and should be, rounded, either in a plain curve or decorated by carving with the chisel. A cornice may have the lower member (or course of brickwork) carved into small dentils, or formed into larger ones by projecting closers; or we may have a dog-tooth or triangular ornament by using bats laid so as to show an angular front.

The old effective spiral or corkscrew twist on pillars or chimney stacks is not very difficult to produce, though requiring time and nicety of handling. For this type of setting the bricks are rubbed or axed to the requisite degree on one face or both, either to produce skews or distinct wedges. With these, and the help of adjusting the thickness of the jointing, a good spiral construction can be contrived. But brick adjustment is the proper thing. Too much reliance must not be placed on varying the thickness of the mortar, as this results in inferior constructional work, and produces a poor appearance.

The entasis, and the diminishing, on a tall and bulky column can be carried out with a minimum of axing and rubbing by careful laying and the use of closers. With smaller columns the work is increased.

A minimum of labour (doing away with all rubbing and axing) on decorated columns is achieved by making the pillars rectangular in plan and using projecting courses. In some cases these projections form rings at frequent intervals. The caps can be formed by setting bats at an angle, or by tile creasing. Indeed, tiles, set flush or projecting, are a very useful addition to such ornamental brickwork as pillar and arch construction. Such admixtures are greatly favoured in fireplace and porch building.

VARIATIONS IN CHEQUERS AND HERRING-BONE PATTERNS

Bricklaying in herring-bone patterns is a very old English device, largely used for nogging in the half timber domestic construction of the Gothic period. It has again come into fashion and is capable of being effectively used in many variations whether with a single coloured or with differently coloured bricks. For instance, the apex of the chevron may be pointing upwards or downwards, and these arrangements may be placed alternately. Or the chevron pattern may be arranged alternately, all one way, or reversed, the apex being placed back to back, or the open ends facing each other. The herring-bone pattern in the horizontal position makes a very good string course, which may be of a harder brick, or one of a different colour, or laid so as to project. This last method, however, has the disadvantage of providing a lodgment for snow and dust. If adopted, it is advisable that the upper edges of the bricks should be rounded off, thus weathering the whole course.

Chequer patterns are usually carried out by using bricks of two different colours. But it is also possible to have chequers of large blocks formed of stretchers laid horizontally and vertically in alternate blocks. Another variation, constantly adopted in modern Dutch work, is to form small panels with stretchers laid vertically on a course of stretchers laid horizontally, so as to break joint, and filling in the spaces between the vertical stretchers with headers. In America panels of chequer patterns are sometimes carried out in headers or stretchers formed alternately with stretchers or headers, the panels or blocks being so arranged as to break joint both vertically and horizontally. This, of course, involves finishing off top, bottom, and sides with half or quarter panels.

Another very ancient type of chequer board pattern, still favoured in stone and chalk districts, is for the walling to be carried out in alternating blocks of stone, or chalk, and brickwork. It makes a quite pretty wall, and in some districts is economical, both on account of the cheaper material and saving of labour. More rarely the panels alternating with the brickwork are of rubble or flint. The brickwork adds strength to chalk or rubble walling and improves the weathering qualities of the former.

A more unusual form of chequer pattern is carried out with headers, or half bats, laid on an angle, thus producing a diamond chequer. This is usually seen in small panels or in string courses, often in wide jointing of coloured mortar.

RAISED TRELLIS PATTERN

The huge Sprinkenhof building at Hamburg (erected in 1928) is built with a " common clinker " brick (of the uncompromising Fletton type), and interest has been given to the façade by covering it with wide-spaced, raised diagonal courses in trellis pattern, forming large diamonds and using terra-cotta roundels. The ground floor piers are slightly stepped forward and terminate at the top in a projecting volute. To interior exposed brickwork, in courts and corridors, interest is given by the sparing introduction of gold bricks (underglaze gilding, burnt in) placed over windows and doorways.

Gauged Work

Gauged work is most commonly used in arch construction and the treatment of pier caps and bases. But it deserves more attention from the decorative standpoint. How by rubbing, axing, and cutting the old bricklayer contrived to adorn walls with arcading, embattlements, build up elaborate architraves and embellished panels with armorial achievements, and even intricate lettering, there are many ancient specimens still in existence to show, and entice the modern craftsman to emulation.

As regards the more elaborate architectural details, the development of the purpose-made brick and the advancement of terra-cotta have largely displaced the work of the brick carver. Terra-cotta castings may lack the charm of the hand axed and chiselled architraves, but they are certainly more uniform and vastly cheaper. So it is only for very special work that fine and intricate cutting of brick can be undertaken.

This, however, with the demand for exposed brickwork in interiors, and greater attention to texture for exteriors, is once more coming into favour.

For this purpose rubbers and other special bricks are chosen, and have to be dealt with by means of the axe and chisel.

Picture Making

By way of suggestion as to what can be done in this way, we may refer readers to some of our illustrations, and to the following instance of modern work in a country residence. A large recessed panel within projecting mouldings was built up over the fireplace in a big dining-room. The mouldings were ordinary bricks projecting 1 inch and rounded in the form of an oval, chiselled to represent a cable. Ordinary bricks, with a few skews, of different colours and textures were used in the execution of the picture, which represented a Viking ship under sail on a swelling sea. Stretchers were laid both flat and on edge, with a few headers, as the design required. The whole set in wide joints of white cement mortar. The sea was represented by alternate courses of light and dark hued bricks, laid in wavy courses, white bricks being used at top, slightly projected and chiselled to form cresting. The ships and sails were also slightly raised and fashioned with small chisels and mallet.

A Novel Bond

In ordinary brick-walling, with bricks of the approximate dimensions now in use, it is scarcely likely that any useful variations in bonding could be introduced, the bonds commonly known having proved their worth for various purposes. While there is no room for experiment in this direction, it is otherwise when we come to consider the setting of facing bricks or veneers, providing these " shells " are duly and suitably keyed, or bonded, into the walling behind. A good illustration of the happy effects which may be introduced by novel bonding in this more restricted field is afforded by a large block of flats, erected to the design of Sir Giles Gilbert Scott, R.I.B.A., in Maida Vale, London. It is a building well worth studying for many reasons: its planning, producing an irregularly stepped frontage, with the intention of acting as a sun-trap ; the excellent use of terra-cotta facings and dressings in large and small blocks ; and the novelty of the brick bond. The architect has used a Sussex multi-coloured facing brick of smaller dimensions than usual, permitting their being laid in a bond showing on the face four headers to one stretcher. Presumably (judging by the great experience of the architect on works of considerable magnitude) the strength of the bond is all that could be desired. On a large frontage, with its moderate penetration, such as this building presents, the appearance produced by the spacing of the bricks is certainly very pleasing.

A German Variation of Bond

Another interesting variation in bond has been introduced by Professor Schaidt, a Berlin architect, in a house he has put up at Rheil. In this case the modification has been applied to the usual Flemish bond by having at fairly frequent intervals string courses of bricks placed on their header ends, thus producing courses having vertical lines, which are equal to two ordinary courses. If these wide courses with vertical lines are used discreetly there is a distinct livening of the appearance, but if introduced alternatively to two of what we may call horizontal courses, the effect is fussy.

A different means to secure liveliness in a plain brick frontage adopted by Professor Schaidt, is to adorn the piers between windows with a chevron pattern secured by stepped projecting headers. Of course, if two of these chevron patterns were joined together one would have either a diamond or a saltire cross, or if the design was continuous on a pilaster, the pattern would be of the trellis order, which is common enough in brickwork, but not with projection. It is a simple handling of an accepted theme which undoubtedly adds charm to a well-proportioned façade. On the other hand, the device would seem to be inadvisable to adopt in a rainy district, as the projecting bricks might easily become the means of introducing moisture into the walling. This tendency could be overcome by using rubbers for the projecting headers and smoothing off the upper arrises so as to induce water shedding and using a weathered struck joint of cement mortar for the setting of these headers. The principle involved was well enough understood by old bricklayers in their decorative carved gauged work. The interest in the German work lies in the simplicity of a method applied to a decorative end and the capability of its wide modification.

Two-coloured Pointing

Attempts to add interest to an elevation presenting large areas of plain walling have been made in many ways, among others by introducing variations in the horizontal projection, but, for the reasons mentioned in the preceding paragraph, these are not always satisfactory. A commoner way is to use dressings of a different material, colour and texture, such as stone, terra-cotta or tiles. A novel method was adopted on the Sparkhaus building, Cologne, by using white and black mortars for the horizontal pointing in alternate lines. The result is that although the wall is absolutely flat, it appears to be built in alternately projecting courses, the black pointing having the appearance of shadows under a projecting course. In this case the vertical pointing is black; had it been white the effect would have been strengthened. In smaller houses it is probable that a less violent contrast would be more pleasing, say, white and grey, or white and red.

Stucco and Brick

Sir Edwin Lutyens, R.A., F.R.I.B.A., has united stucco and brickwork on elevations in a most striking way on the huge tenement blocks on the Grosvenor Estate, Pimlico. These elevations present the appearance of immense chequer boards, the result of the peculiar penetration and odd treatment of the face of the walling. The windows are rectangles, practically square, with inconspicuous white framing. The piers, or walling, between, of equal width with the windows, are of plain brickwork. The blank walling, above and below the windows, is of equal height with the windows and is divided into panels corresponding to the windows and piers above, alternately stucco and plain brickwork, so arranged as to alternate the red and white panels with the window spaces and brick piers above. The daring conceit unquestionably arrests attention, but it seems rather to emphasise the unhomely, barrack-like character of the buildings. However, there appears to be the germ of an idea here.

Chimney Stack and Garden Fountain

Kingsley Hall, Bow, Mr. C. Cowles-Voysey architect, is blessed with a flat roof, utilised as a garden. It is specially worth mentioning owing to the ingenious way in which the uncompromising nature of a large chimney stack has been brought into the architectural scheme to serve a double purpose. On one side of the chimney stack is an alcove, on the other a picturesque garden fountain.

An alternative way of dealing with the problem is to place benches against the long sides of the stacks. When this is done it is well to have brick wing walls, with gracefully curved coping, and a projecting canopy above, either by recessing the bench or by means of corbelling, as a protection against weather and falling " blocks."

Open Brickwork Flower Boxes and Walling

A railway engineer's way with throw-out bricks is worth mentioning. Making a polygon platform of bricks, laid flat or on edge as circumstances required, but without any cutting, he proceeded to build up a shrub-tub or flower-pot container by laying bricks in the stretcher-header course of Flemish bond, but leaving the headers out. The coping was a complete course. Some of these boxes had straight sides, others were corbelled, so that in tall examples the top course was a full brick width in advance of the base course. Naturally the boxes could be rectangular, octagonal or of any suitable form.

The same method can be usefully applied to retaining walls in gardens, where the soil is of appropriate consistence. The open spaces in pots and walls not only act as weepers, but are delightful crannies for growing ferns, small rock plants and not too aggressive creepers.

Brickwork and Tile Hanging

A picturesque and economical way of cottage building seen in Kent and Sussex is to have solid brick walls for the ground floor, with timber and plaster for the upper floor and tile hanging for facing. As a rule rectangular unglazed tiles are used, the lower course being first pegged and bedded in mortar, the upper ones slightly overlapping. Each course must break joint vertically with the one below. Sometimes glazed tiles are used, and these may be of different colours, alternately in line or in course. In other cases the alternate courses of tiles have square and semi-circular ends. The latter must be allowed extra overlap to secure adequate protection, so more tiles are required, and those with rounded ends generally cost more than the rectangular kind. While pegging is desirable, it is not absolutely necessary if the tiles are provided with good strong nibs or cogs which key into the mortar beds.

An Ornamental Gable

The accompanying illustration (Fig. 171) is given both as a useful design for a gable, with window opening, and showing what varied possibilities there are in the laying of bricks. It will be noted that both sides provide several alternative ways of disposing the bricks,

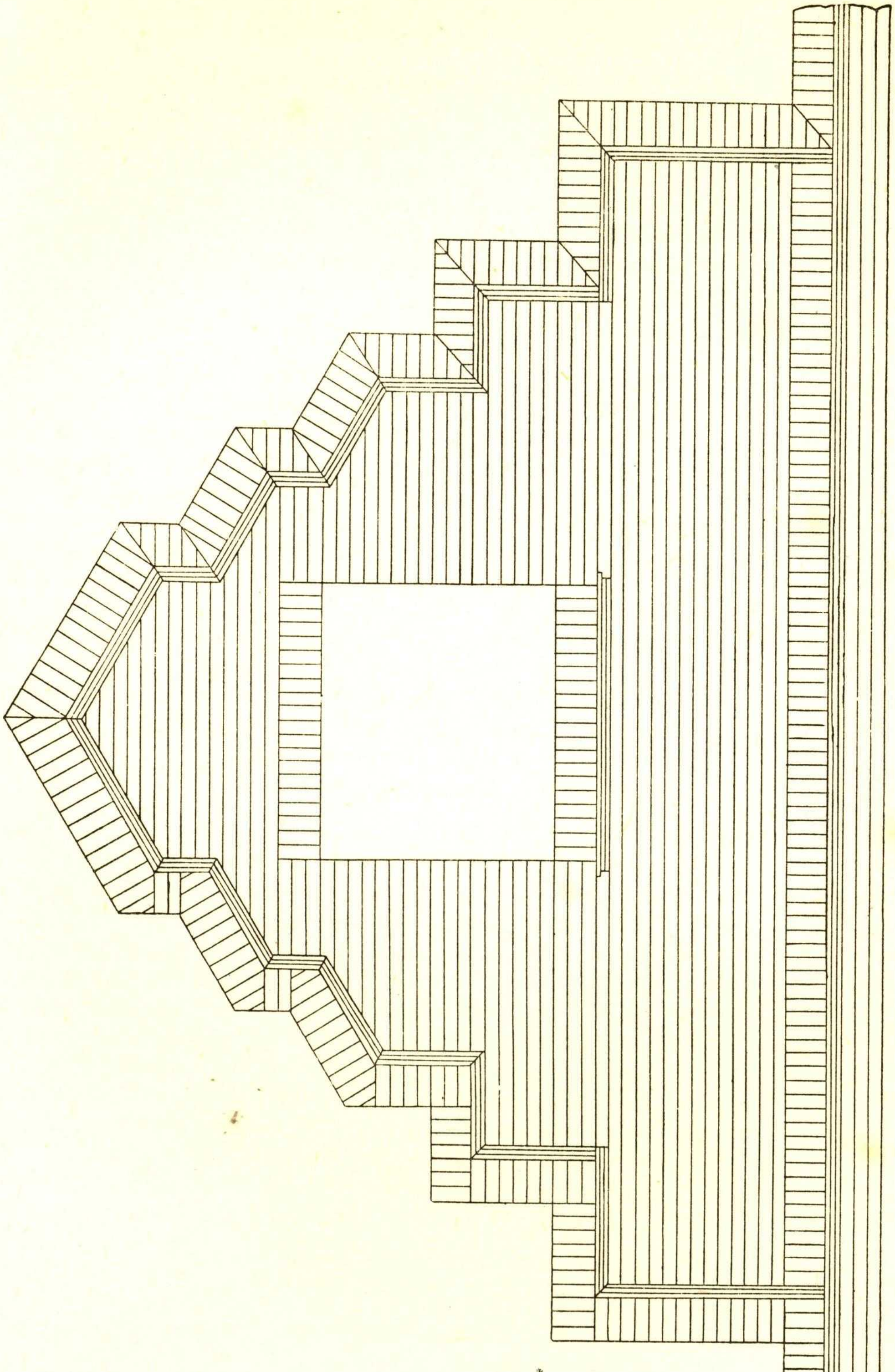


Fig. 171.

all of which are sound structurally while having different and distinct decorative values. Only ordinary plain bricks are shown, cut with the trowel or axe where necessary. This is particularly interesting in connection with the mitreing. For the forming of the different angles the scutch and the bevel are needed as well as the trowel. Tiles have been introduced in a natural and restrained yet very effective way. Their use under the sill course of bricks on edge is specially worthy of note.

CHAPTER XVII

STRENGTHENING AND ADDING TO WALLS

Underpinning—Building Cover to Underpin adjoining owner's Building—Shoring : Raking Shores ; Horizontal Shores ; Vertical or Dead Shores—Underpinning Walls—Underpinning by Piers—Scaffolding : the Bricklayer's Scaffold ; Tubular Scaffolding—Toothing and Racking : Block Bonding, or Toothing New Work to Old ; Indents ; Racking Back—Thicknessing of Walls—Compound Walls.

It will be convenient to consider together various methods adopted when it is necessary to strengthen walls or to add to them. As regards the joist, these include both temporary and permanent measures. As regards the latter, when future extensions are contemplated the work is finished off in such a way as to leave toothing, which is formed by projecting bricks which furnish keys for the bonding. In the absence of toothing, other steps have to be taken to secure bonding.

UNDERPINNING

Underpinning falls into two sections : (1) for temporary work ; (2) for permanent work.

In the first place, temporary underpinning is merely a device for supporting a wall, or part of a wall, which has been cut from its foundations for any purpose (such as the insertion of a damp-proof course, or replacing a damaged one, providing an opening, etc.) while the repairs are being carried out and allowed sufficient time to set. This is almost always done by timbering or shoring.

As regards permanent work, underpinning may be described as the downward extension of the foundations of an existing wall to a lower level, for the purpose of strengthening that wall. This may be rendered necessary owing to faults developed in the natural foundation, or soil ; in the structure itself ; in order to withstand lateral pressure, or to compensate for extra load, such as the addition of a story.

As regards lateral pressure arising from adjacent buildings, it will be useful for the bricklayer, or general foreman on the job, to know the regulations of the London Building Act on this important point. Section 93 of the London Building Act, 1894, states :

Building Owner to Underpin Adjoining Owner's Building.—" Where a building owner intends to erect within 10 feet of a building belonging to an adjoining owner, a building or structure any part of which, within such 10 feet, extends to a lower level than the foundations of the building belonging to the adjoining owner ; he may, and if required by the adjoining owner shall (subject to hereinafter provided), underpin or otherwise strengthen the foundations of the said building, as far as may be necessary, and the following provisions shall have effect."

These provisions deal with the notice which the building owner has to send to the District Surveyor, stating the time when he proposes to commence the work or building and whether he intends to carry out the underpinning or strengthening of the foundations. This has to be accompanied by plans, sections, etc., of proposed building, and also depth of excavations.

If, for instance, a building owner in London intended to build a large building (for example, large office in the City) on a site at either side of which there were already existing buildings, and the owner intended to excavate to a much lower level on the site for his proposed building, he would have to strengthen these existing buildings on either side before proceeding with his own building. Before proceeding with the excavation work which would be required in the operation of underpinning the existing walls, it would be necessary to support the walls by means of shoring.

Shoring.—In the case of walls in fairly good condition which are required to be strengthened by underpinning, the object of shoring will be to retain the position of the walls till the operation of underpinning has been completed, and the wall made permanently secure. In the case of a dangerous wall, which overhangs considerably, the object of shoring would be to hold the wall in position and to prevent further development of the danger, until such time it is convenient to take it down or demolish it. In some cases where the vertical position of the wall has not deviated outwards to any great extent or has slightly bulged in places, it has been possible by shoring the wall to straighten it so as to retain its vertical position. The wall would then have to be secured either by one or two piers or buttresses, or by a series of ties from the face of the wall, extending some distance back to a division wall, or extending much more in length to a back wall. One or other of these methods would have to be adopted to keep the wall in its vertical position; but these methods are not very satisfactory and are not advised, as they sometimes lead to further complications.

There are three classes of shores: (1) Raking Shores; (2) Vertical or Dead Shores; (3) Horizontal or Flying Shores.

(1) ***Raking Shores.***—These consist of a piece or pieces of timber, usually placed in an inclined position, one end of which rests upon the ground and the other against the vertical surface of the wall. The angle generally used for practical purposes is 60 degrees to 70 degrees. While sometimes the raking shore may consist of a single piece of wood, at others it is necessary to have several pieces. These naturally vary according to the height of the raking shore. The position of the top end of the raking shore is usually determined by the position of the various floors. The floors resist the thrust from the top of the raking

shore when it is placed in position against the wall. If it were placed in position so that the top of the shore came to a point between the two floors, there would be nothing on the internal portion of the wall to resist the thrust of the shore when against the wall, therefore there would be a liability of the wall being pushed inwards by the thrust of the shore. So the top end of the shore should be placed against a point of the wall where there is something at the back of the wall to resist that thrust. Therefore, the best practical point to define, if the floor plate is on the same wall, at which the raking shore is thrusting, will be a point on the external wall where the angle of the shore meets a little below the horizontal level of the bottom of the floor, which is bottom of the floor plate which carries the floor. The point at which the top of the shore meets the wall at the angle is again altered if the floor joists run parallel with the wall which is to be shored up, instead of resting upon it. In this case the thrust from the shore should be directed at a point central with the centre of the floor wall and shore. The defining of this point of thrust is very important, because security of the wall depends upon these points. After defining these points two important matters to be considered are good sound material and good craftsmanship. The absence of either leads to serious consequences. If a number of timbers are required for shoring at various floors at different angles, all these defined points of thrusts should be studied in each inclined shore.

Fig. 172 shows the position of a raking shore against a wall and also the various details connected with it. The first step in a method like this is to fix into position against the wall a piece of wood in a vertical position to receive the head of the shore. This piece is called the wall plate. It is usually about 2 inches by 9 inches, and its length varies considerably according to the number of raking shores which are to be placed in position against it. Sometimes a number of these wall plates are placed vertically above one another against the face of the wall, where there are a number of shores to be placed in position and the building is of a considerable height. These are usually held fast by a number of wall hooks or cleats which are driven in the wall at each side of the wall plate. When it is necessary to use a number of these wall plates the joints should be made secure by halving them and then fixing them with spikes to make sure that there will be no movement longitudinally in the whole length of the wall plate. At a point in this wall plate, that is near the thrust point at the top of the raking shore, a hole should be cut through the plate, extending the thickness of the plate, and also extending into the brickwork about 4½ inches at least. This hole through the plate and brickwork should be 4½ inches by 3 inches by 7½ inches. It is formed in order to receive a piece of wood, called a needle. This needle is placed into the hole and is usually about 15 inches long. This is shown in Fig. 172. The outside end of the needle finishes in a line with the outside face of the raking shore. The needle

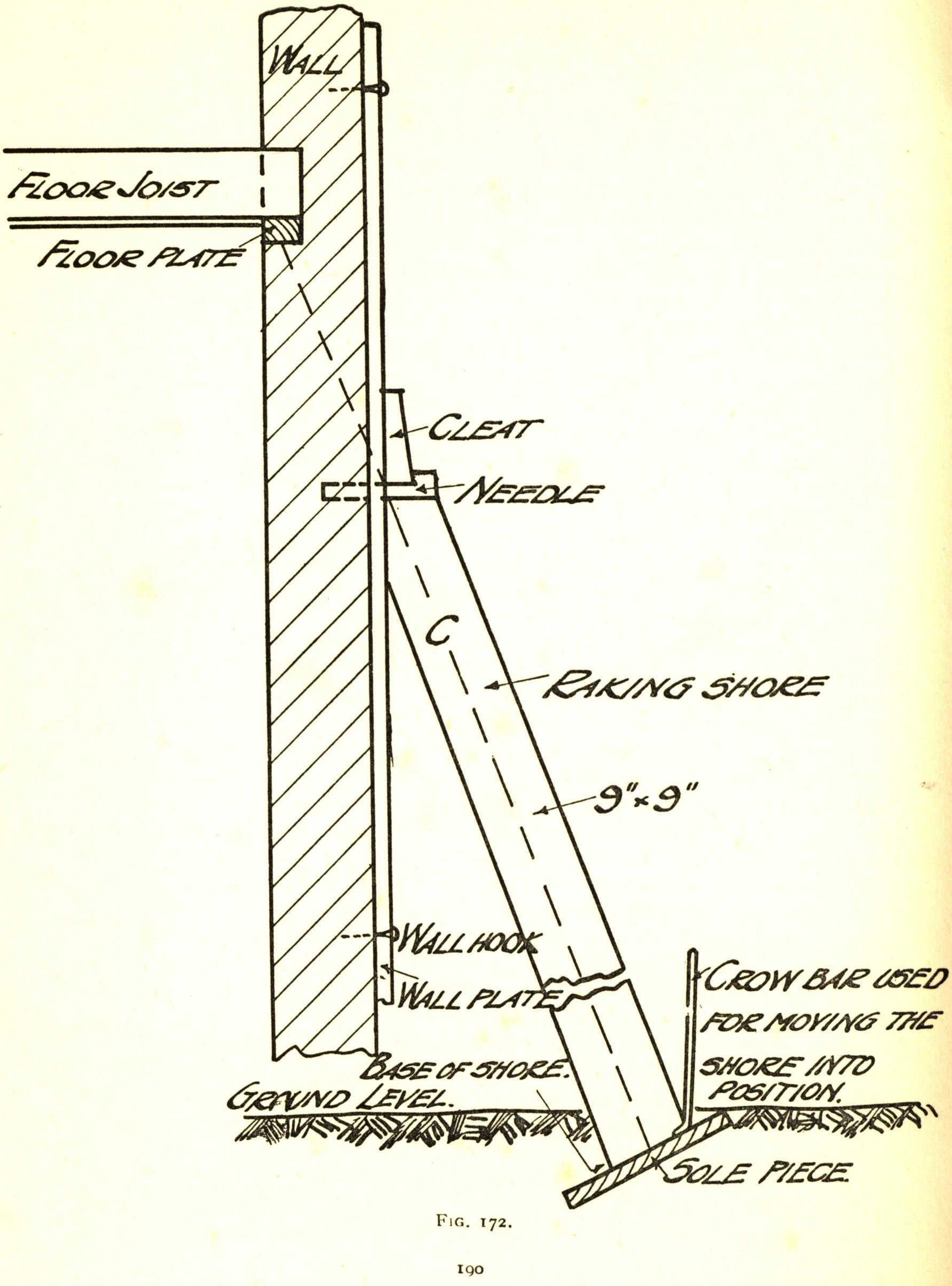

WALL
FLOOR JOIST
FLOOR PLATE
CLEAT
NEEDLE
C
RAKING SHORE
9"×9"
WALL HOOK
WALL PLATE
CROW BAR USED FOR MOVING THE SHORE INTO POSITION.
BASE OF SHORE.
GROUND LEVEL.
SOLE PIECE.

FIG. 172.

when in position forms an abutment for the head of the raking shore. A cleat is then fixed (as shown) into the rebate of the needle and against the face of the wall plate. This keeps the needle in a horizontal fixed position, when the thrust of the raking shore is brought against it.

The raking shore can now be placed into position. The size of this is usually 9 inches by 9 inches, or 12 inches by 12 inches. The top end of the raking shore is notched out centrally the width of the needle. When this is placed into its correct position the two side projecting portions of the notch keep the shore in position, and prevent any movement sideways. The bottom end of the raking shore, or the base of the shore, is held in position by a piece of flat timber called the sole piece. This is usually 12 inches by 3 inches, and its length varies according to the number of shores required. It is placed at the bottom of the shore and well bedded in the ground. This is usually placed at an angle of 35 degrees with the existing level. This sole piece is placed in position and the raking shore is prized into position tightly against it. Fig. 172 shows the centre line of the raking shore, pointing in a direction immediately to the centre of the wall plate; this should be the position of the thrust.

Horizontal or Flying Shores.—Flying shores are usually placed between the outside wall of two buildings or between two walls, or where in cases it is necessary to remove an existing building in between two buildings, in which case the walls of the two buildings which are to remain have to be kept in a vertical position by means of placing in position shores. These usually consist of a horizontal timber fixed tightly between two wall plates. The wall plates should be fixed vertically in position by the method as above described, and the holes for the needles made in the same way. The flying shore is usually about 9 inches by 9 inches or in some cases 7 inches by 7 inches, according to its length, etc. On the top and on the bottom of the shore are placed in a central position two pieces of wood called straining pieces, which are usually 4 inches by 2 inches. These can be fixed before the shore is put into its horizontal position. Before placing the horizontal shore into its position two pieces of plate must be placed and fixed on to the wall plate to carry it. This can also be done before the wall plate is fixed. The wall plate with the blocks fixed to it, which are to take the weight of the horizontal shore temporarily, can now be placed and fixed in a vertical position against each face of the wall. When in position the horizontal shore can be fixed and wedged tightly between the two plates. The position of the holes for the needles can be ascertained by placing a strut provisionally in position the foot of it against the straining piece, and the top of it in a line with the thrust, which should be the centre of the floor plate as shown in diagram; or if the joists are parallel with the wall, the centre of the struts should be in a centre line with the centre of the floor. The usual position to fix the struts is at an angle of 45 degrees. These can be adjusted by the lengths of the straining pieces on the top and bottom of the horizontal shore. The wall plate is now held in a firm vertical position against the face of the wall (Fig. 173).

Vertical or Dead Shores.—This is a system of shoring which is used for temporarily supporting the upper walls of houses or shops,

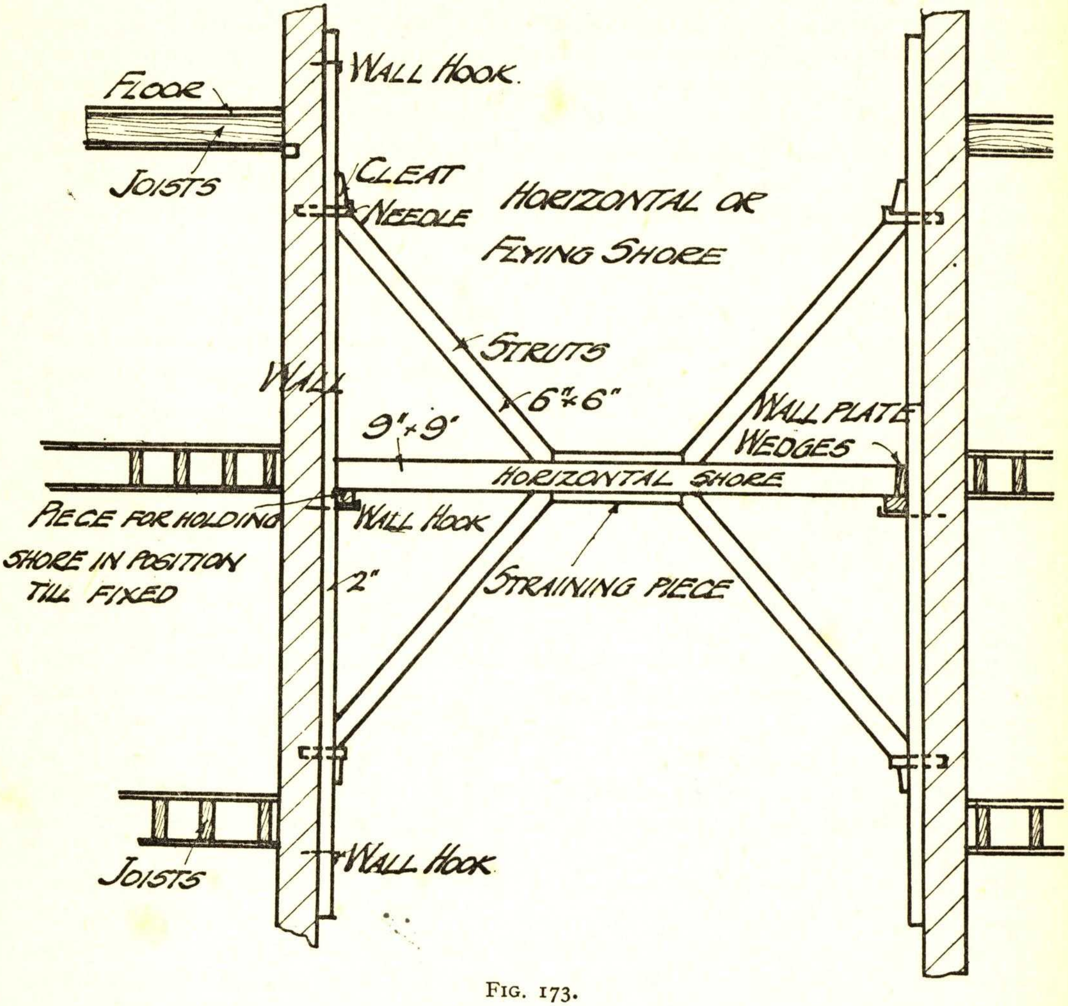


FIG. 173.

when the bottom part is required to be removed, in order to strengthen the foundations, remodel old foundations, or, for instance, to make openings for large shop fronts, etc., when practically all the lower portion of the brickwork has to be removed in order to insert a large girder to take the weight of the brickwork above it. In such cases a system of shoring has to be carried out in order to carry the upper portion of brickwork temporarily during operations. For instance, we will take the case where an old shop front has to be converted into an up-to-date shop. An old wooden beam carries the existing front, this has to be taken out and a rolled steel joist inserted in its place; therefore all the old front has to be removed in order to insert the new shop front. The first step to adopt is to strut up all the floors from the ground floor to the roof, or if there is a basement, to strut up from the basement to the roof, first of all starting the strutting from a solid base. When this is completed it has taken the weight of all the floors and the roof off the walls, thus leaving the weight of the wall only to be considered. The next step is to strut all the window openings above the shop front, with wall plates and horizontal struts. If any arches are weak, they should be held in position temporarily by securely fixing and strutting a centre piece under the soffit of the arch. In very bad or old fronts, raking shores should be used as well to support the front, and to avoid the wall from moving from its vertical position. When the position and height of the new rolled steel joist on the front elevation have been ascertained, it very often happens that the new steel joist has to carry the floor either on its top flange or between the bottom and top flanges. This point should also be carefully studied. The structure now being temporarily secure, a series of holes will have to be cut through the wall. These holes should be made large enough to enable pieces of wood, usually about 9 inches by 9 inches, to be placed through them in a horizontal position. These pieces of wood are needles and they should not be placed at a greater distance than 6 feet from each other. (That is, horizontal distances apart.) Great care should be taken in cutting out the needle holes, especially in very bad brickwork. The top horizontal face of the needle should fit tightly against the brickwork above it, and carry the weight of it. This is possible in good brickwork, where the bottoms of the bricks which rest upon the needle are solid and possess a good horizontal surface; but in very old and bad brickwork the bricks are liable to break and crumble. In such cases a large surface is required to take the weight upon the needle, therefore, as shown in detail in Fig. 174, a spreader is inserted, and placed in position on the top of the needle, in order to obtain a larger area in which to carry more weight of the wall above it. In new or practically new brickwork the needle only is required to carry the weight of brickwork above it, as the bond also helps to carry the weight of the brickwork between the spaces where there is no needle. The elevation in Fig. 174 shows the ends of the needles carrying the brickwork between the needles in the spaces. It will be noticed that one or two bricks have fallen from the brickwork. This very often happens after the brickwork has been removed from the bottom portion of the building. The vertical or dead shores are usually about 12 inches by 12 inches. These are placed as shown in Fig. 174 in a vertical position upon a base timber. This timber is called a sleeper and is usually about 13 inches by 13 inches. There are two base timbers or sleepers upon which the inside and outside vertical shores are placed. It will be seen in the diagram, Fig. 174, that

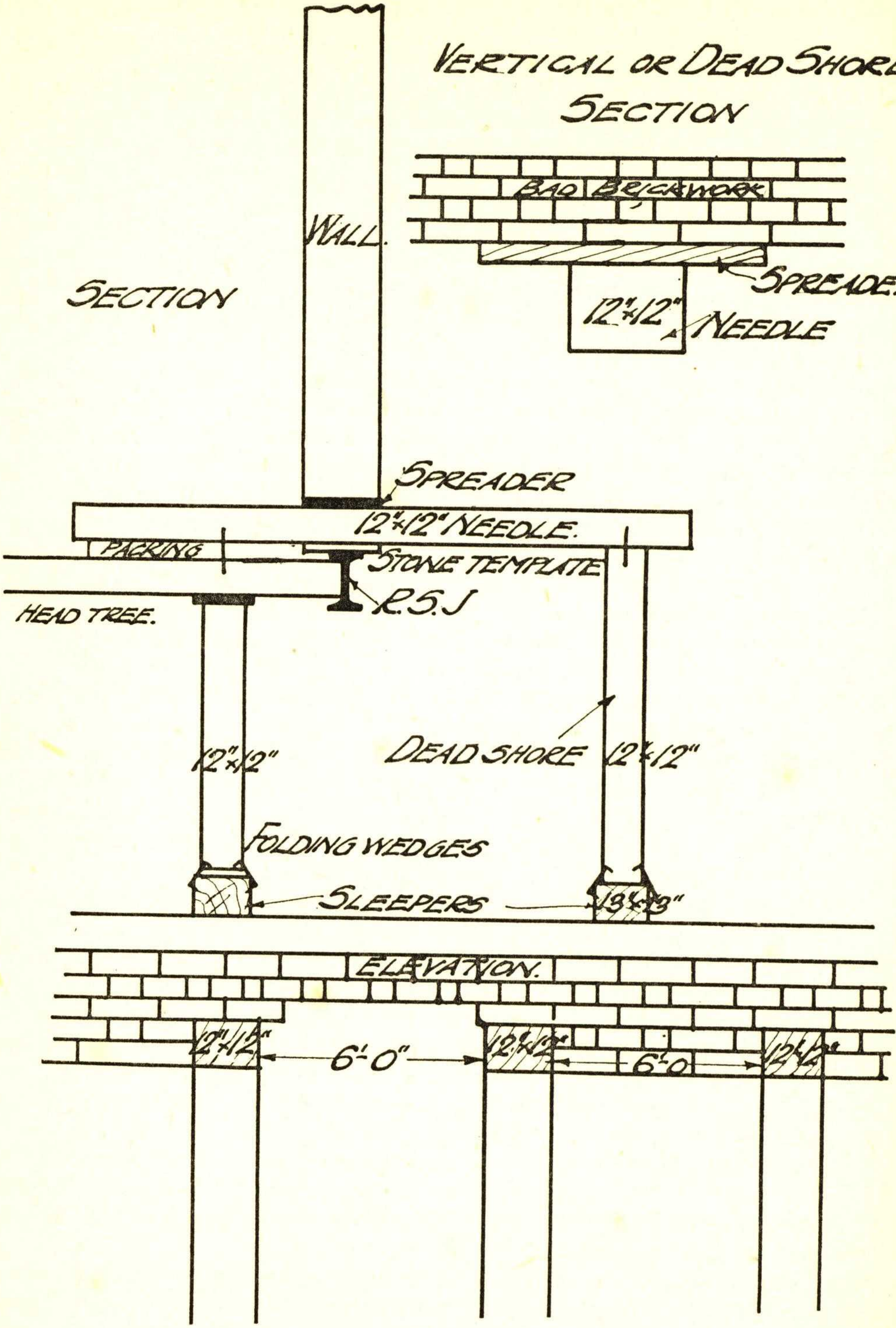

VERTICAL OR DEAD SHORE
SECTION
BAD BRICKWORK
SPREADER
12"×12"
NEEDLE
WALL.
SECTION
SPREADER
12"×12" NEEDLE.
PACKING
STONE TEMPLATE
R.S.J
HEAD TREE.
12"×12"
DEAD SHORE
12"×12"
FOLDING WEDGES
SLEEPERS
13"×13"
ELEVATION.
12"×12"
6'-0"
12"×12"
6'-0
12"×12"

FIG. 174.

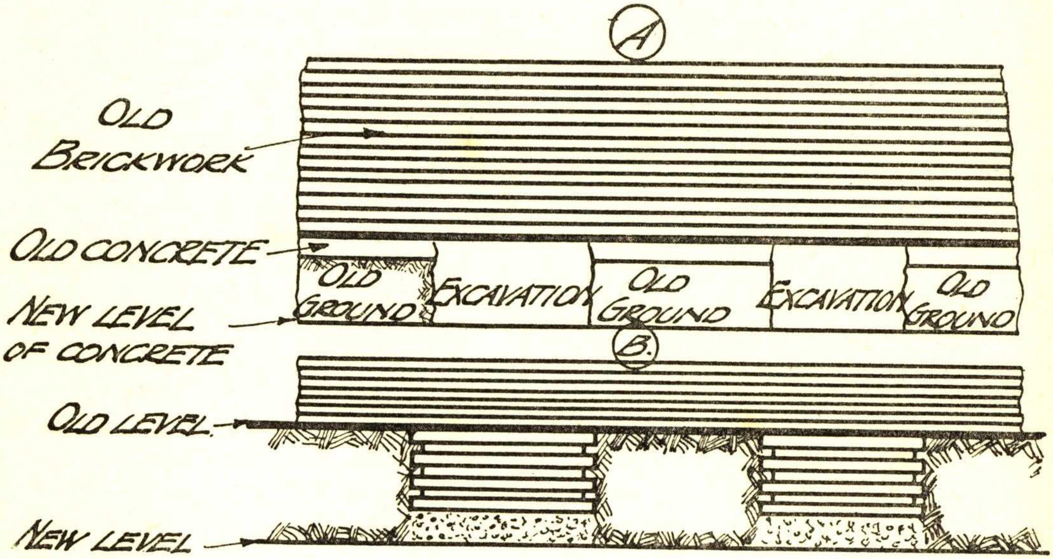
one vertical shore is placed outside and one inside the building. The vertical shores are held in position at the base by dogs. These are pieces of iron turned at right angles at each end, one end being driven into the sleeper, the other end into the vertical shore. Upon the outside vertical shore is placed the needle, which runs through the wall at right angles. The inside portion of the needle, that part which is inside the building, rests upon a packing which is placed on the floor. The inside vertical shore is placed on a sleeper and extends to the bottom surface of the floor above. On the top of these inside vertical shores is placed a board about 1½ inches in thickness which runs at right angles with the floor joist. This is called a head tree piece. This vertical shore is tightened up into its position by means of folding wedges at its base. The vertical shores now are taking the weight of the horizontal needle, which in its turn takes the weight of the wall. The spreader is shown on the top horizontal surface of the needle. All the under-side portion of brickwork can now be removed, leaving a clear space for the rolled steel joist to be placed into its position. This usually rests on two York stone templates which are placed on the top of brick piers, at each end of the opening. When the rolled steel joist has been placed into its position, and securely built in at each end, a course of stone templates is usually bedded on it, in order to build that portion of brickwork between the templates and the existing brickwork above it. The portions of brickwork are then built up to the existing old work between each needle, and thoroughly tightened up.

When all these portions have had reasonable time to set the needles are withdrawn, and the needle holes made good. The floor and window strutting can next be removed. All portions of the brickwork which require making good should be built with good hard burnt bricks and a good cement mortar. Seven to ten days should be allowed after the brickwork has been pinned up, from the rolled steel joists to the old existing brickwork, before any needles are taken out, or any struts taken from the windows, etc.

Underpinning Walls.—This is a very important branch of the bricklayer's craft and should be carried out with great care and judgment. Underpinning a wall usually means that the wall has to be strengthened at its base. For this purpose we excavate or remove the earth or concrete at its base so as to obtain a lower level or a firmer foundation, on which is placed concrete, and on this brickwork is built to fill in the space between the lower level which we have obtained and the original level of the old work. This space must be filled in with care, so as to form a solid mass between old and new levels, with a view to avoid any future settlement of the existing wall.

Fig. 175 shows an elevation of an old wall which is to be underpinned. The old brickwork is marked, also the old concrete of the existing wall. The new level is also marked with arrow. This new level is the distance from the old walls under surface which it is proposed to underpin.

The first proceeding is to excavate to the new level. Naturally it would be a very dangerous thing to excavate the ground under the wall for any great length, therefore, according to the stability and condition of the wall, short lengths of ground are excavated at various distances apart, as shown in the diagram A. The older the brickwork the shorter the lengths of the excavations. For old brickwork 4 or 5 feet is sufficient for the length of the excavation. In practically good brickwork, well bonded, the lengths of these excavations can be 6 feet to 7 feet with the same length of solid ground, or old ground, between each excavation. By this means the existing lengths of old ground between each excavation carry the weight of the wall, until each excavation has been filled in with new brickwork.



FIGS. 175 and 176.

Fig. 176 shows the excavations filled in with new concrete and brickwork and pinned up to the old existing wall. If we have a very long wall to underpin, this method should be carried out throughout its entire length. When these portions of new brickwork have had reasonable time to set (which should be at least a week), the intermediate portions of ground between the new brickwork can be excavated to the new level and filled in with concrete and new brickwork, and pinned up tightly to the old wall.

Fig. 177 shows the underpinning work completed from the new level to the old level.

It is now possible to explain in detail the method of underpinning one of the sections which have been excavated ready for building the brickwork. After the new concrete has been placed into position, which should be horizontally level, lengthwise and crosswise, the distance from the top surface of the concrete to the underneath surface of the existing wall should be carefully taken, in order to gauge the number of courses of brickwork that will be required to fill up this space. Four courses of brickwork measuring 12 inches are the usual gauge. Each course of brickwork, from the concrete upwards, should be well bedded and flushed up and made perfectly solid. When nearing the top three or four courses care should be taken to see that the under side of the old existing wall has been thoroughly cleaned off, and a good under surface procured for the last course of new brickwork to be placed against. The last course of the new brickwork is the most important. This is really the pinning up or tightening course on which much depends. For instance, as in Fig. 178 we have an 18-inch wall, the last course consisting of two rows of headers. The first row of headers should be placed in position and in doing this a good bed should be spread for them to rest upon ; also the top or frog of the brick should be well spread with mortar before being placed into its position. It should then be pushed into position, care being taken to keep as much as possible of the top mortar from being removed from the brick. To ensure this joint (that is the one between the last new course of bricks and the bottom course of the existing wall) being solid, a short stick should be procured and used, in order to push the mortar in the joint solidly. When this course has been solidly built in by this method the other course of headers can be treated in the same manner. By this means solid joint can be obtained at this important point. It is sometimes advisable to use a hot cement, that is to say, a cement that will slightly expand when set, because this would undoubtedly procure a tight solid joint between the old and new brickwork.

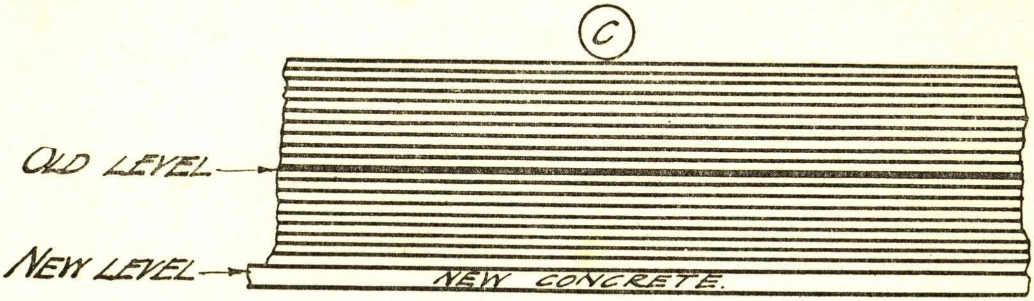


FIG. 177.

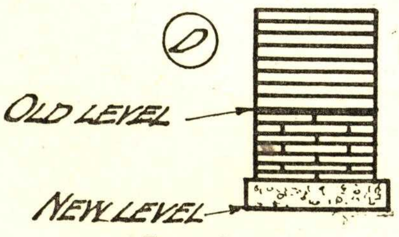


FIG. 178.

The same method of underpinning would also apply in the case of pinning up brickwork on a rolled steel joist, and old existing work.

Another point in underpinning, as shown in the diagram A, is that care should be taken to obtain exactly the horizontal level throughout the whole length of the wall. There would also be a great danger if one portion of the wall was not quite solid, as such a weak spot would probably at a later period cause a settlement.

Underpinning by Piers.—Where the subsoil is of unequal bearing power or subject to flooding, underpinning by piers is sometimes resorted to. This generally entails considerable excavations and extensive shoring. Then piers are carried down to a solid natural foundation, and carry reinforced concrete beams and brick arches to support the walls above. Apart from the actual bricklaying, this is difficult work. The brickwork must be of the best and precautions must be taken to ensure perfect bonding between the piers and the beams or arches and these supporting platforms and the footings of the old walls. The dimensions of the piers should be regulated by the nature of the soil and the weight to be supported.

Scaffolding: The Bricklayer's Scaffold.—A bricklayer's scaffold is a temporary structure to enable the craftsman to proceed with the work of building walls, etc. It is composed of a series of uprights which are called standards (Fig. 179). These are fir poles varying from 15 to 35 feet in length and anything from 4 inches to 6 inches in diameter at the base, tapering in diameter in their length upwards. These are usually placed from 8 to 10 feet apart, and certain distances from the face of the wall, according to the width of scaffold required. Scaffolds may be increased in height by lashing poles to the standards in a vertical position.

Standards are fixed at their base by either placing them in boxes or barrels which are filled with sand or earth and rammed, as shown in the illustration; or by placing them in a hole in the ground, usually about 3 feet in depth, and ramming in the earth firmly around them. A base is sometimes placed at the bottom of the hole, such as pieces of wood 3 inches by 9 inches or a piece of stone, etc. This stops the standards from sinking. Poles, called ledgers, are next placed in a horizontal position against the standards and tied by means of a scaffold cord. These are placed at distances of 5 feet vertically from the ground upwards. As the wall proceeds to the height of one scaffold from the ground a series of holes is left in the wall, usually half-bricks. The top surface of the ledger pole is horizontally level with the bottom of the holes (called putlogs holes), into which pieces of wood are placed, one end resting in the hole, the other end resting on the top surface of the ledger. The section in Fig. 180 shows these putlogs resting on the ledger, and at the other end proceeding into the wall. These are usually made of birch or beech and vary from 3 inches to 3½ inches square; the length is from 5 feet to 5½ feet, and they are placed on the ledgers about 4 feet apart or sometimes less, according to the length of scaffold boards which are used. Upon these putlogs are laid scaffold boards, which are usually about 12 to 13 feet in length, 9 inches in width, and 1½ inches in thickness. Generally the corners at the ends of the boards are cut off at an angle of 45 degrees. A saw-cut is made a short distance from the end on each side of them. Hoop iron is then fixed on the end edge of the board and made secure by being placed into the saw-cuts at each side. This method of encasing the ends of the boards with hoop iron prevents them from splitting at the ends, which often occurs when the boards get in a dry condition and shrink. Scaffold boards are sometimes laid with butt joints on the putlogs and sometimes lapped over each end. When butted against each other two putlogs should be used at this point about 4½ inches apart, for the butted ends to rest upon. The width of the scaffold, that is, the distance from the face of the wall to the standard, should be 4 feet 6 inches at least. Some scaffolds are composed of six boards in width and others of five boards.

In the elevation on the highest scaffold two boards laid horizontally on the outside edge of the scaffold will be noticed; these rest against the standards and are called guard boards. They prevent any material from falling off of the scaffold. These boards are nailed to the standards to keep them in a vertical position. There are openings generally left in the guard boards, where there is a ladder which is tied to the ledger. This opening must be wide enough for labourers to land with materials.

When the building is going to proceed to a good height the standards have to be doubled at the base, and lashed together. This is done by lashing short stout standards with the original standard. These short stout poles are usually about 12 feet long and the next standard is placed vertically on the top of this and lashed with the original standard. By this means the standards are taken up to a great height. The system of bracing consists of tying and lashing poles together, as shown in the diagram Fig. 179. These are in the form of a triangle, which prevent the movement of the scaffold. Where there is extra weight to be placed upon a scaffold, the scaffold is then lined with a double thickness of scaffold board.

Tubular Scaffolding.—Alternative methods of scaffolding are now much in use, especially for large buildings. Among these is the patent iron tubular scaffolding, which is very light and quickly put together, the vertical and horizontal tubes socketing into each other and being fastened by clamps.

Toothing and Racking: Block Bonding or Toothing New Work to Old Work.—Toothing is carried out in several ways. One way consists of the end or temporary end of a wall being left with projecting bricks which are called toothing. These projections are usually the stretchers in each alternate course, standing out 2¼ inches at the end of the toothed wall.

Indents.—Fig. 181 gives a view of the toothed end of a wall. The longer length just above it is an illustration of indents in a wall. One is a 9-inch indent and the other a 4½-inch indent. Indents are recesses in the face of a wall, in which every alternate course is recessed back

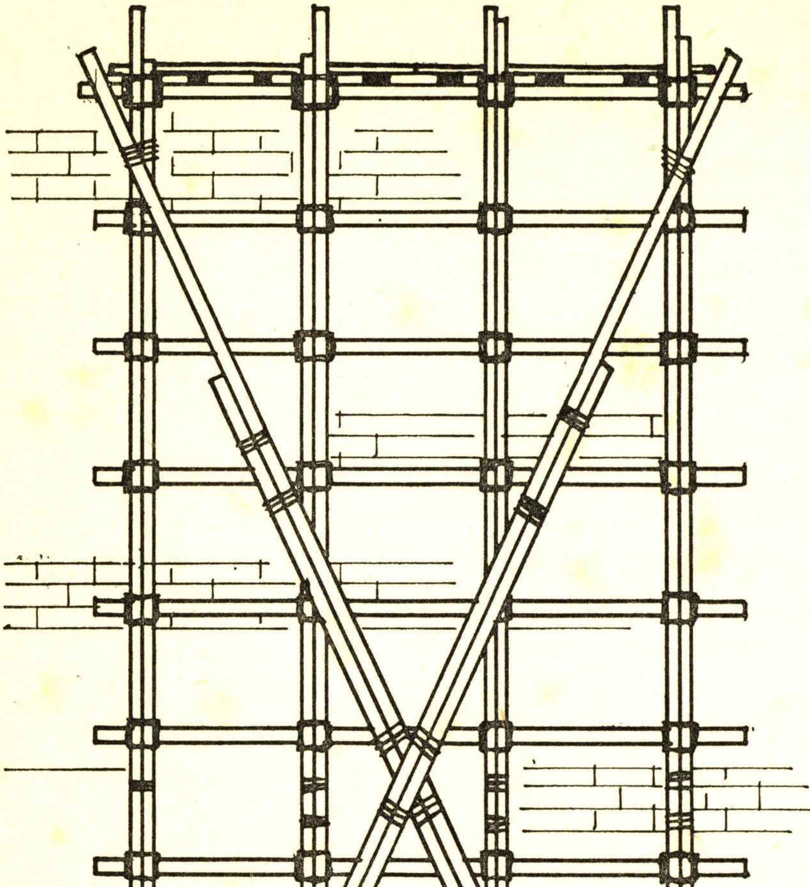


FIG. 179.

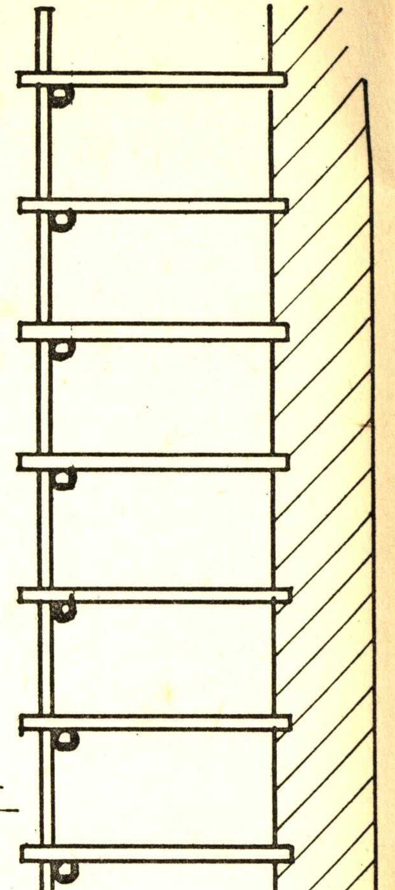


FIG. 180.

from the face of the wall 2¼ inches, and in some cases 4½ inches. Walls are built into these indents of various thicknesses from 4½ inches to 18 inches in thickness, these being ordinary sizes, though, of course, much larger walls are built into indents at times.

Fig. 182 is an illustration of a new wall which has to be joined or built into an old one. The depth of the indents in these cases from the face of the wall is at least 4½ inches, and much better connection can be made by having these recesses 9 inches from the face of the old wall. Three courses are indented, or recessed, in each indent. This forms a much stronger connection when the new wall is bonded into the old

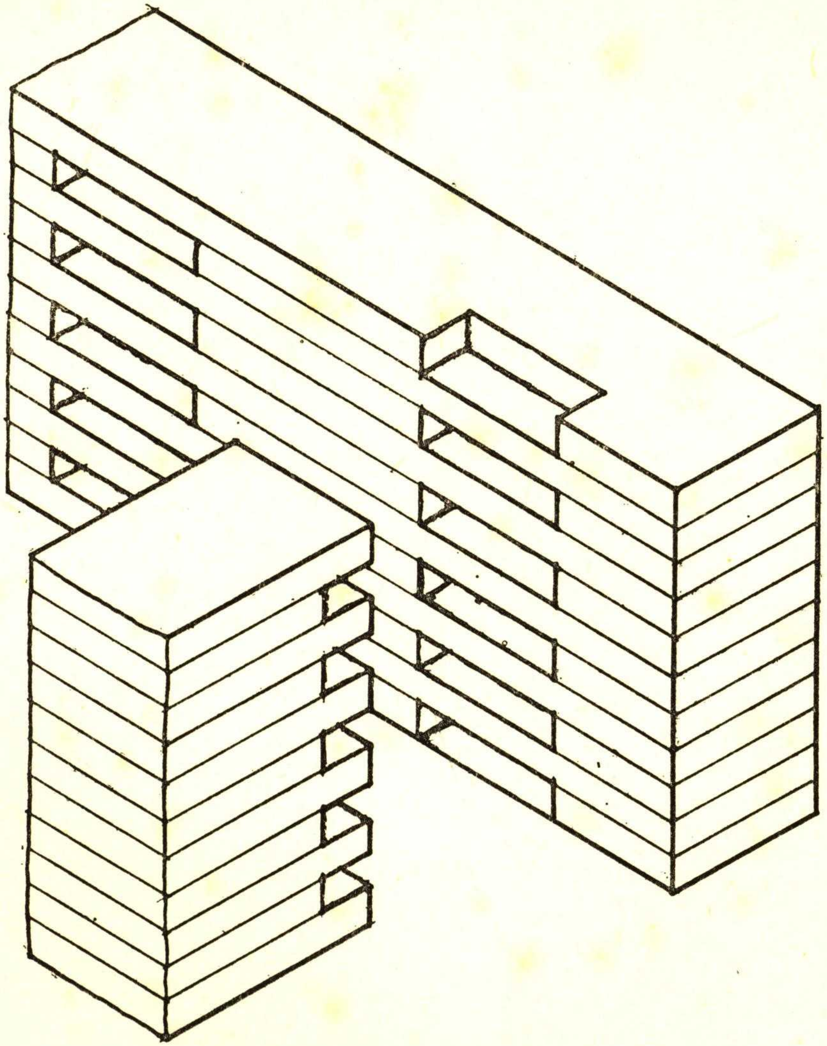


FIG. 181.

one. In some cases hoop iron is introduced and laid on the new wall, which is tailed into the old wall for 9 inches.

The old work should be well cleaned and all old mortar cleared out of the indents before the new work is built into it. It should also be thoroughly wetted and flushed in with a grout cement.

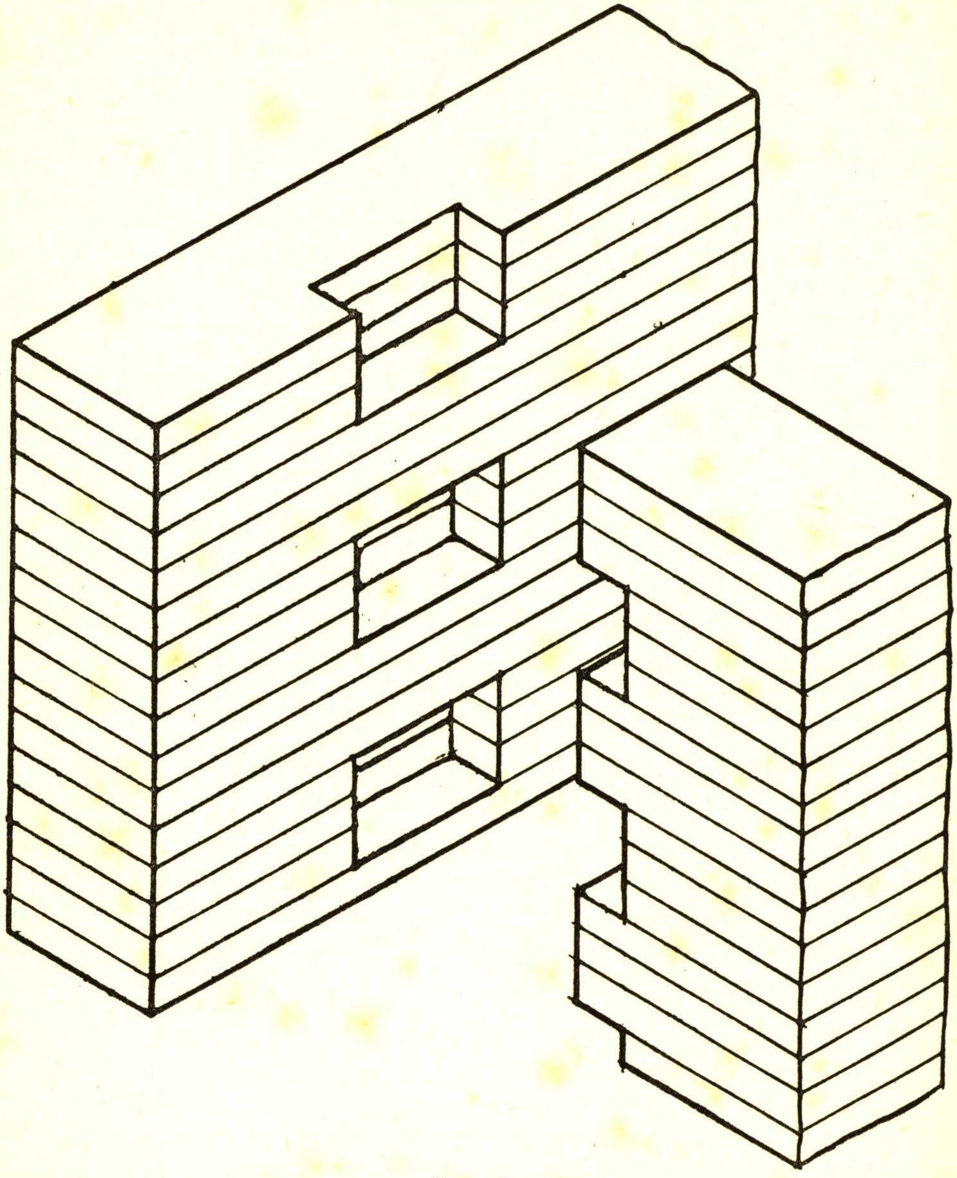


FIG. 182.

Single indents, that is, indents which are recessed every alternate course, are not very strong when made in old work, as the bricks often break and corners fall off, and when the new work is built into them there is a weakness at the joining point. The block toothing being much thicker than the single toothing, it is able to withstand a greater weight at this point of junction than the single course of bricks.

Racking Back.—This is the term given to the ends of walls which are kept temporarily in order to receive a portion of brickwork at a later period. The racking back of the wall is formed, as shown in the illustration (Fig. 183), by setting back each course at quarter bond over the preceding one, until the height of a scaffold is obtained. This method is usually carried out when building corners to a building, which are usually left for a short period before the remaining brickwork is built to them. Corners should always be racked when being built, and not toothed. If racked at the corners, the weight is spread over a large area when brickwork is built over them. There are various forms of the racking back of walls. Fig. 183 gives an illustration of the method of racking back the wall when English bond is used. The second course sets back 2¼ inches from the end of the stretcher in the first course; the stretcher is marked S and the header is marked H. The third course sets back the width of the header plus half the width of the header next to it. These two headers are marked HH. This larger set back from the end of the header in the second course occurs every second course; so in the racking back by this method we have first course set back 4½ inches plus 2¼ inches from end of brick in every other course until the height of brickwork is attained. That will be first, third, fifth, seventh, and ninth course setting back 6¾ inches, and the second, fourth, sixth, and eighth course setting back 2¼ inches from end of stretcher in preceding course.

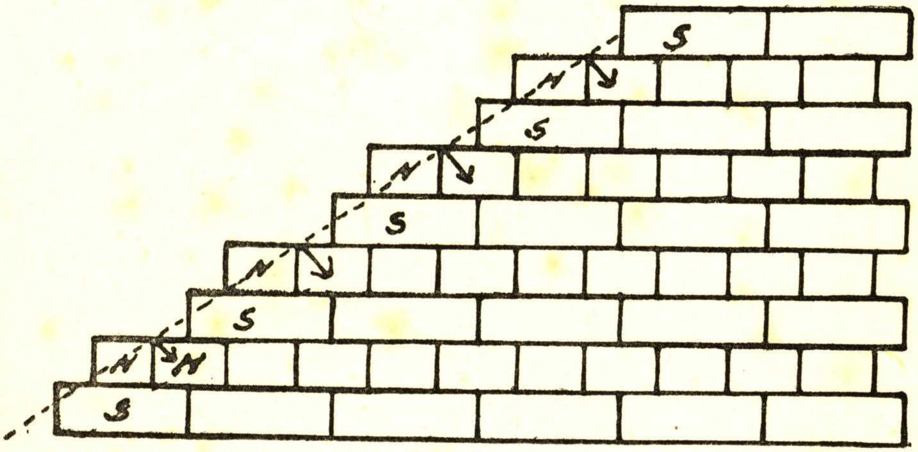


FIG. 183.

Another way of racking back is by setting back the second course 6¾ inches, that is to say, the header in the second course is set back

6¾ inches from the end of the stretcher in the first course. So we then have the second, fourth, and so on, courses setting back 6¾ inches, and the first and third, and so on, courses setting back 2¼ inches from the preceding heading courses. In the first method in which headers are placed at the end of the heading course, and not covered by the course above them, there is a possibility of these bricks getting removed from their positions. The second method is the best for racking back when English bond is used, as the stretcher keeps the end headers in position. The arrows from the dotted line show the headers in the second method being held in position by the stretcher in the course above them. Fig. 184 gives a view of racking back as used in Flemish bond. This is the method generally adopted. It is partly toothed and partly racked back; the method being that every third course is toothed over by the fourth course by 2¼ inches; the first course setting back from the fourth 6¾ inches; the second course setting back from the first 2¼ inches, and again the third course setting back from the second 6¾ inches. So we have in this method the following set backs: first course, 6¾ inches; second, 2¼ inches; third, 6¾ inches; fourth toothing, 2¼ inches over the third. In this method there are not so many bats isolated at the rack end which are liable to misplacement. The dotted line shows the method of all the bricks racking back. There again we have all the headers isolated at the rack end and liable to misplacement. Fig. 185 is an illustration of stretching bond. In this case we have a uniform racking back of the bricks in each course, each course receding back from the one below it by a distance of 4½ inches or half of the stretcher. Each brick in this method is bonded in and secured by the one above it. Fig. 186 is an illustration of heading bond in which all headers are used. In the racking back of this wall as shown we get a uniform receding

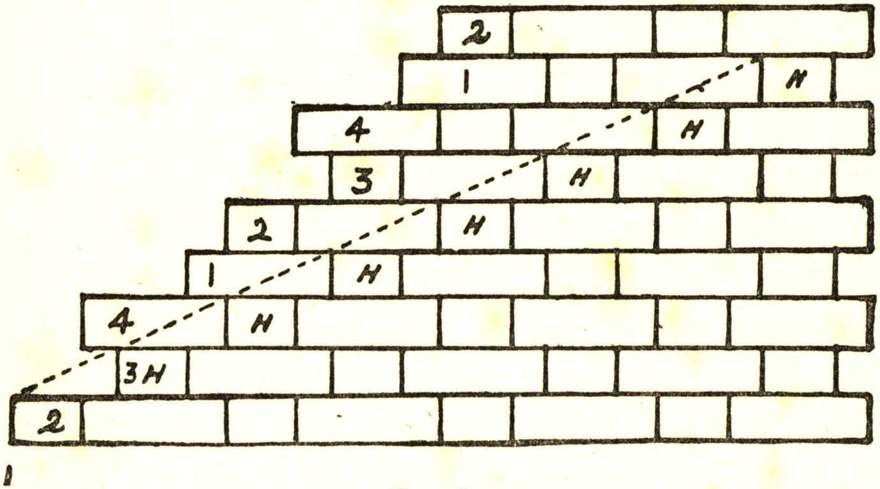


FIG. 184.

back at the end of each course from the one below it for a distance of 2¼ inches.

In the case of a toothing there is always a weakness at the point where there is a mass of brickwork built afterwards over that toothing, especially when the wall is being joined into the toothings and the joints are not carefully made solid. When new work is being toothed into new work, the top portion of the brick, where it rests under the projecting brick, should be solidly filled with mortar as well as the bed of the brick. It is at these particular points where the bricks are broken, such as the 2¼-inch end of the stretcher, if not filled in solid on the underneath bed, or the top part of the header which is bedded under it, that weakness shows itself. The majority of architects and clerks of works will not allow the corners of the buildings to be toothed, but insist on their being racked out in order to avoid this weakness.

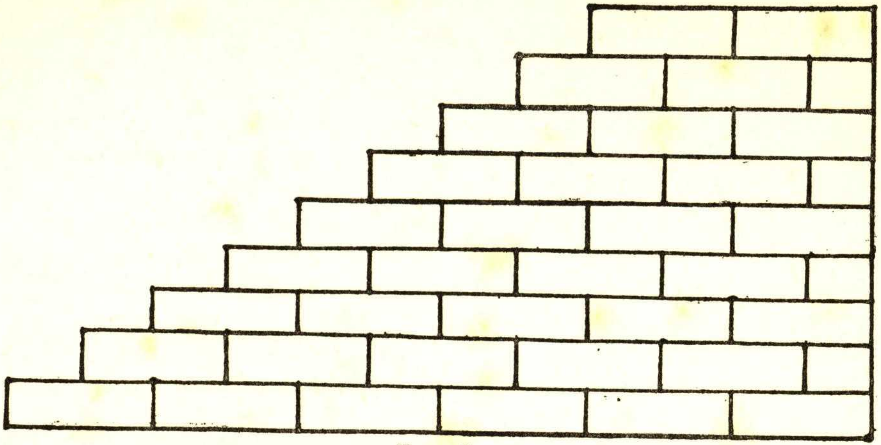


FIG. 185.

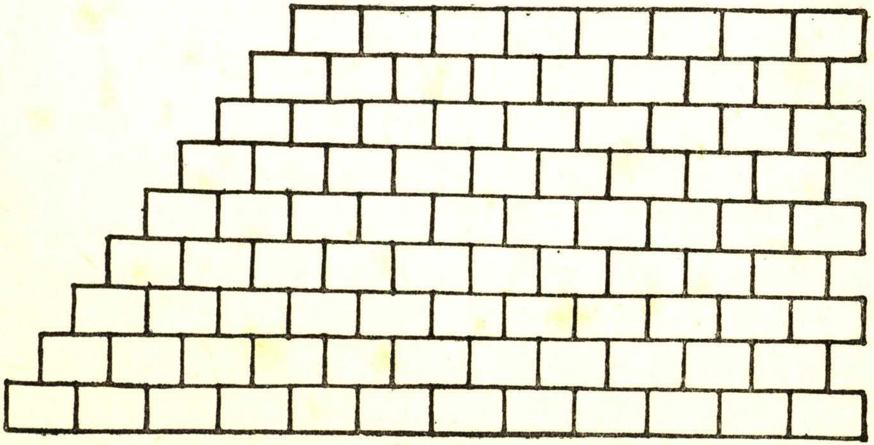


FIG. 186.

THICKNESSING OF WALLS

The thicknessing of walls is carried out by a variety of methods. The thickening of a wall on the face of it is sometimes called recasting.

We will take a case of an old dilapidated wall, where all the joints or most of them have finished on the face of the wall. Such a wall requires thickening 4½ inches over the entire face of it. The bonding of the new work into the old is a very important point, and care should be taken to see that it is carried out as specified. Fig. 187 is an illustration of the elevation of the old wall into which the new work has to be bonded. This shows a series of holes which are cut into the wall 9 inches from the face. The hole is 9 inches in depth, showing three courses. For the convenience of placing the bricks into the hole, the first course is a stretcher in width, the second course three headers in width, and the third course again is a stretcher. When bonding the new work into this shaped hole, there is no need to cut any of the new bricks; all whole bricks can be used, thereby making a much stronger bond into the old work. The 4½ inches by which the wall is required to be thickened should be well bedded and flushed up in each course as laid, so as to procure as good a key as possible to the old work. If English bond is specified for this work, the headers will have to be cut every alternate course. This also applies to Flemish bond. As a rule, in this class of work, the English Garden Wall bond is used. This, as already explained, consists of three stretchers and one header alternately along each course. In that case the headers for three courses could be tied into the wall, and in the next three courses the headers could be snapped and not tied into the wall. This method could be worked alternately throughout the face of the wall.

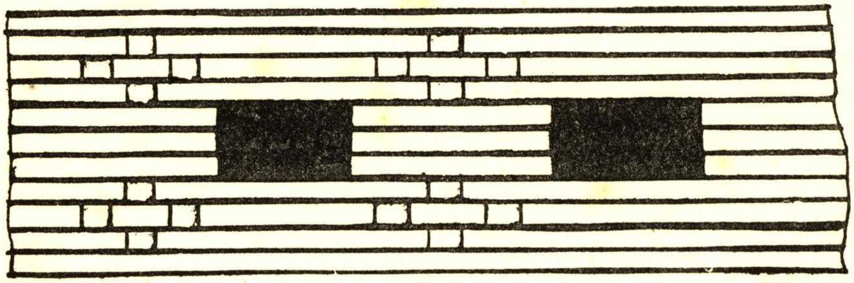


FIG. 187.

Fig. 188 shows another method in which a wall is thickened 4½ inches on the face. The illustration shows an elevation of the old wall in which every fourth course of brickwork is cut out throughout the length of the wall. This should be cut out at least 4½ inches from the face of the wall. Therefore, a convenient bond to be used in this case would be three courses of stretchers and one course of headers, which would form the bonding course into the old wall. By this means all whole bricks can be used throughout the whole face of the wall, except at the corner, where a three-quarter could be used in the stretching course. A reinforcement can also be used in connection with the heading course, by bedding a layer of patent wire or Exmet on the heading course, which should be 8 inches or 9 inches wide. This will form an extra key at this course. Sometimes holes are made larger as shown in diagram, 18 inches by 9 inches, and 9 inches back from the face of the wall.

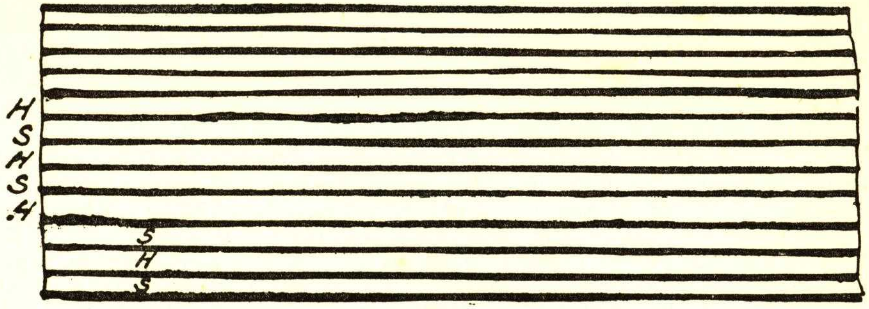


FIG. 188.

Fig. 189 shows another form of bonding into the old work, when a 4½-inch brick thickening is used on the face. It consists of a number of holes, which are cut 4½ inches into the whole work, into which headers can be bonded. The bond to be used in this instance will be the Flemish.

Good material should always be used for thickening walls ; a good cement mortar in the proportion of 2 parts of good Portland cement to 1 part of sharp, clean sand, mixed thoroughly with clean water. If walls are dirty they should be well scraped and hacked before the new work is built up against them, so as to provide a good key for the mortar.

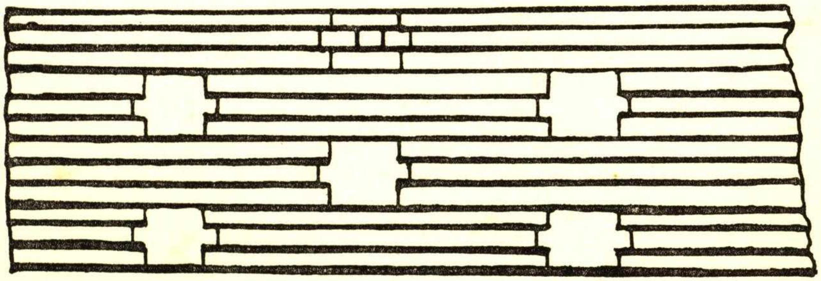


FIG. 189.

Compound Walls.—These are walls which are composed of two or more materials. For instance, a wall which is built up with an outside face of stone and the internal face of brickwork. Or we may have a wall with a granite face on the outside, with brickwork inside. Fig. 190 gives an illustration of a compound wall with corner blocks of stone. These are bonded and tied into the wall. Each course, or block of stone, corresponds with the thickness of four courses of brickwork. The courses of brickwork, which are at the back of the stone blocks, should be gauged to the stone block in front of them, and should be horizontally level with the block of stone, when the fourth course is finished internally so as to ensure a level bed for the next stone (which is a bonder, or bonding stone). When it is bedded on the one below it, part of this will also rest on the internal brickwork below it.

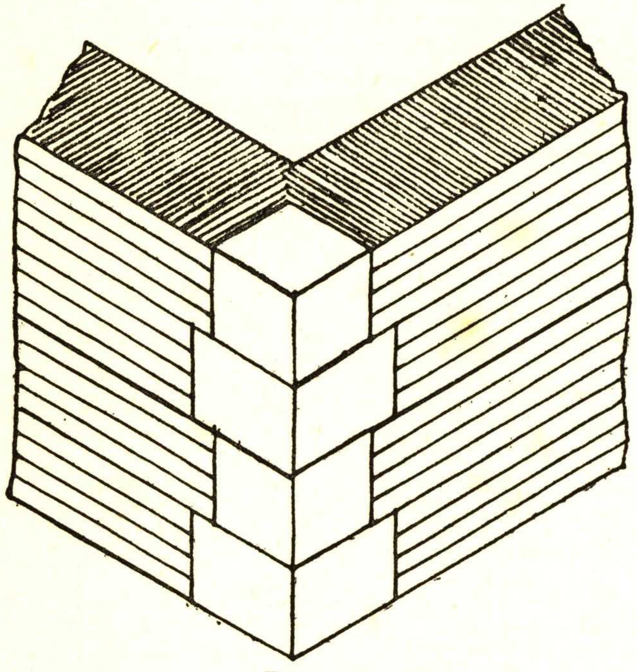


Fig. 190.

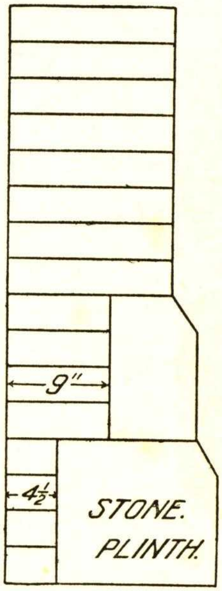


Fig. 191.

Fig. 191 is an illustration of a section of a compound wall, showing two blocks of stone which form stone plinths at the base of the wall. These are bonded into the brickwork, the 9-inch thickness of brickwork tying the bottom stone plinth in; the smaller stone plinth at the top is tied in by the thickness of the brickwork above it.

Fig. 192 gives the section of another compound wall, the external face of the wall being built with blocks of stone and the interior face of the wall in brickwork. The stonework blocks are bonded in every other course, the 14-inch thickness of internal brickwork tying in the block of stone below it each time—that is, every other course of stonework. The 14-inch thickness of internal brickwork also bonds together the 9 inches of brickwork and the block of stonework in the four courses or underneath it.

Fig. 193 gives the section of a wall in which bricks of different thicknesses are used in the construction. The ordinary sized brick is used internally, and a thinner brick is used on the external face of the wall. Therefore, the gauge of the brickwork vertically will be different on each face. So in the illustration it will be seen that the outside courses, which are much thinner than the internal course, have a gauge of five courses to the foot. The internal courses have a gauge of four courses to the foot. The fifth external course, being a heading course, forms a tie into the wall, the first, second, third, and fourth external courses being 4½ inches in thickness on the face. If English bond is used on work of this description, a large number of whole bricks will have to be cut to form headers. In that case the first, third, and fifth will be heading courses, one and three being all half bricks, and the tie-in course, which is the fifth, will be whole bricks and headers on the face of the wall. A thick joint, between the internal third course and the external fifth course, is unavoidable on account of the different thicknesses of the internal and external bricks. The gauge rod required for the external work should be divided into twelve divisions and these 12-inch divisions should be divided into five equal parts, so that the top of each course can be gauged as the work proceeds. Each fifth course ties into the wall alternately in the height of the wall.

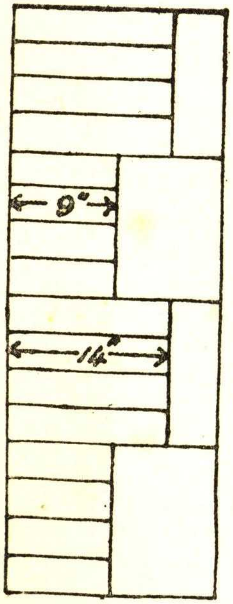


Fig. 192.

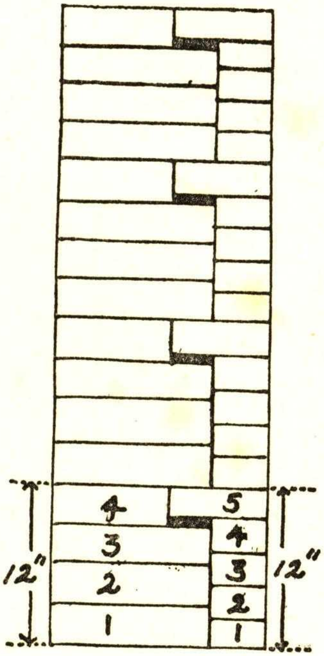


Fig. 193.

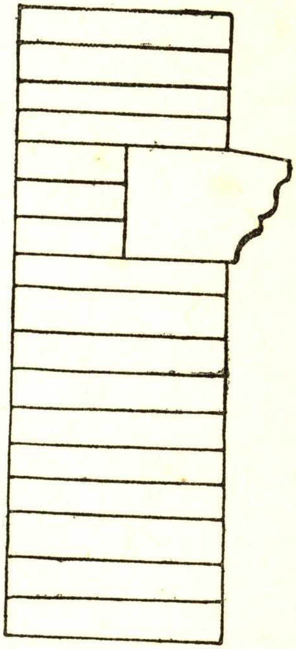


Fig. 194.

Fig. 194 gives the section of a wall showing a stone cornice built in the brickwork. Care should be taken to bed the stone cornice solidly, and also horizontally level from front to back. If heavy cornices are bedded near the top of a wall, sufficient brickwork should be built above them to tail them down or hold them firmly in position.

When a projecting cornice is a soft limestone, the top should be weathered and covered with lead flashing tailed into the brickwork, and the base should be throated, the brickwork being protected by good lead soakers.

CHAPTER XVIII

BRICK IN COMBINATION WITH STEELWORK

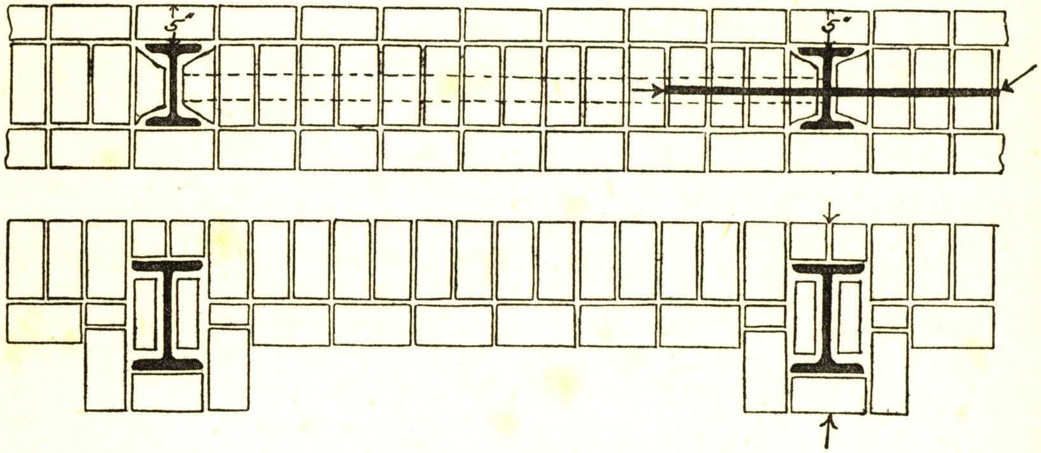
Of late years brick and steel have been largely combined in buildings of all classes, the steel forming the frame and the brick being used as external and internal screen walls and generally for masking purposes. The combination is a strong one and practically fireproof, but only if the steel is suitably coated to prevent rust. Such protection often takes the form of two good coats of lead paint. A satisfactory substitute is the application of liquid cement, applied with a large brush and allowed to dry before the steel is further handled. The painting is done either before or after the steel framework has been erected. Should the steel not be protected in this way, damp would find its way through the brickwork and set up oxidation, with the production of rust, which weakens the metal frame and stains the bricks, and through them the plaster or other decorative lining. Rust, by causing the steel frame to expand, may result in the brickwork being displaced, especially as the mortar or cement joints will be attacked. In special work, such as carved finials, parapets, cornices, and other decorative work, cramps and reinforcement, copper, Delta metal, or stainless steel should be used instead of ordinary steel.

By way of illustration a bad defect examined by the author may be mentioned. It was the case of a 2 foot 6 inch brick parapet on a large flat roof which was found to be seriously overhanging the face wall. The roof was constructed with rolled steel joists, with light breeze filling, and a surface finish of asphalt. On inspection it was discovered that the parapet wall had been forced forward, so that it over-sailed the face wall by 1¼ inches. The displacement had occurred exactly on the same level as the rolled steel joists on the inside of the wall. The cement filled between the parapet and roof, which was covered with asphalt, had cracked, most of it having broken away from the inner face of the parapet wall, thus leaving a space practically the whole length through which rain gained access to the steel joists. The ends of the joists (laid at right angles to the parapet wall) were pressed tightly against the brickwork and were covered with rust. The result of the combined rust and temperature expansion of the joists was the thrusting outward of the brickwork. In this case the ends of the joists should have been free, they, and the whole length of the joists, well protected from moisture. No doubt the thinness of the coat of breeze, cement, and asphalt conduced to excessive expansion of the steel; this would have been lessened if the joists had been encased in brickwork.

Brick walls and piers in combination with iron or steel in structures subject to considerable vibration, such as bridges, some classes of factories, etc., should be built free from actual contact with the metal, juncture being established by means of perforated bricks placed with iron or steel tie-bars in a perpendicular position through them and painted over with Portland cement.

As already mentioned in another chapter, wire mesh and expanded metal strips are used as reinforcement for strengthening walls and arches, especially at junctions of walls or at points where one wall is bonded into another.

Piers of different shapes and dimensions are sometimes reinforced by perpendicular Rolled Steel Joists. In other instances it is a matter of merely casing steel stanchions or pillars with a veneer of brickwork.



FIGS. 195 and 196.

In Fig. 195 we have the plan of an 18-inch flank wall of a large building in which R.S.J.'s are spaced at intervals as vertical stanchions, forming an important part of the framework of the edifice. When setting out the framework these are placed in their correct positions, lined up, plumbed, and usually braced together or strapped by a diamond brace or an angular brace in the spaces between each stanchion. Two of these stanchions are shown held in position by means of a channel of iron placed horizontally as shown by dotted lines. This channel is usually riveted into the web of the stanchion by means of an angular plate, one side fitting to the web and the horizontal side fitting into the horizontal base of the channel iron. Welding is now gradually replacing riveting, as this method, while lessening the amount and weight of metalwork, also gives a stronger structure. The whole of the channel iron as well as the stanchions are built into the brickwork. The stanchions are usually worked to a true face line, and in many cases the bricklayer foreman can take his measurements for the external face of the brickwork from the face of the flange or the stanchions. There is a space of 5 inches from the stanchion face to the external face of the brickwork. This method of construction greatly strengthens the brickwork, especially in certain buildings, such as cinemas, where the external walls are taken to a considerable height, and where cross walls are a great distance apart, thus weakening ordinary structure.

In Fig. 196 we have the plans of a different type of wall, in which stanchions are also used in combination with brickwork. The wall is 14 inches thick, and the stanchions stand beyond the face of the wall, piers being built round to cover them.

In both these types of walls the brickwork should be well grouted in, especially in close proximity with the iron or steelwork. Sometimes the stanchions are encased in strips of wire mesh before being encased with the brickwork. This is to provide a good key for the mortar, which works its way through the mesh and binds metal and brick firmly together. Such added reinforcement gives strength and makes the work easier. It will be seen that the mortar between the flanges at both sides holds the brickwork on the one side to the internal wall and on the other to the face of the pier. Both positions are marked by arrows. Another way of forming a key with material round the stanchion is to have a series of iron bands round it at intervals of every six courses of brickwork. These can be round or rectangular in section. A third method is to insert horizontal round bars through holes in the web of the stanchions at regular distances apart. These bars should be turned up at each end and tailed into the joints of the brickwork. This provides good ties between stanchions and brickwork, but if too many are placed in the webs at short distances apart, the web will be weakened. Yet another alternative is to rivet iron bars to the web on each side, which should be of a good length and turned down at their ends. This method is shown in Fig. 195, the bar running through the web of the stanchion and turned down into the joints of the brickwork at each end, as indicated by arrows.

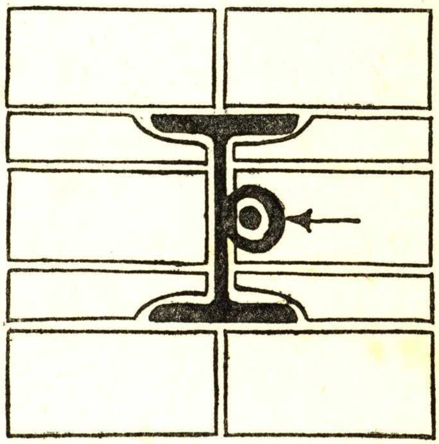


FIG. 197.

In Fig. 197 we see a R.S.J. built into in a square 18-inch pier. This is necessary to give strength to a pier carried to a considerable height, which has a large surface exposed to wind pressure, or which may have to carry a heavy weight. In some cases a pipe is carried close to the web of the R.S.J. to contain an electric cable, gas pipe, etc. This is indicated by the arrow.

An octagonal pier is shown in Fig. 198. It is reinforced by a R.S.J. and surrounded by wire meshing to secure the better key, as already mentioned.

A circular column, built in gauged brickwork and neat cement, is shown in Fig. 199. Piers and columns built in this way are very often reinforced with R.S.J.'s, especially when very tall. The outside 4½-inch thickness is first built up, and the inside is then thoroughly grouted with cement.

Iron or steel is sometimes used for partitions, when it is necessary for their being extra strong. A substantial partition can be formed by placing R.S.J.'s at about 5 feet apart in an upright position and strapped at the bottom and top with strap irons of from ⅜ inch to 2 inches, according to height and thickness of the wall, their ends turned down to overlap the webs of the stanchions. The R.S.J.'s should be 3 inches by 3 inches, the intermediate spaces being filled in with 4½-inch brickwork, bedded in a good cement mortar, and the whole rendered, inside and out, with a coat of cement and sand, about ½ inch to ¾ inch thick. The flanges of the R.S.J.'s should be covered with wire mesh to afford an efficient key for the cement rendering.

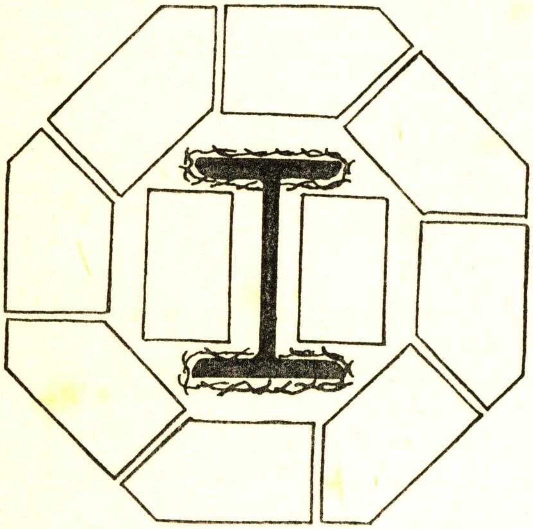


FIG. 198.

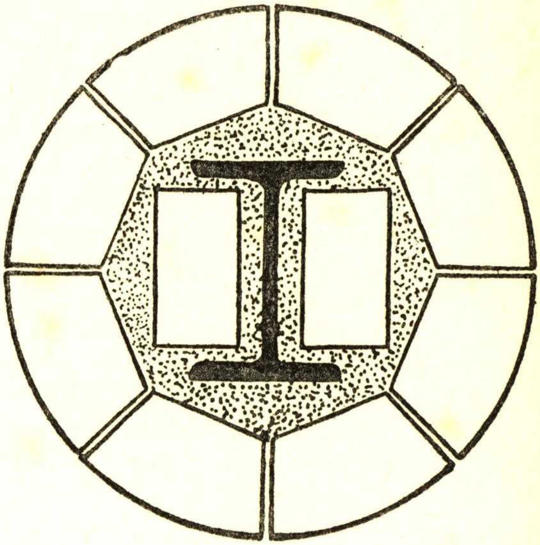


FIG. 199.